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THE ROENTGEN RAY AS AN AID IN THE DIAGNOSIS OF DISEASE OF THE NASAL ACCESSORY SINUSES[1]

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THIS paper is not presented with the idea that it introduces anything new either in technic or interpretation. The technic used is a combination of well-known methods which, in my work, has proven satisfactory in the study of sinus disease. The roentgenologic findings may be of the greatest help to the physician treating diseases of the accessory sinuses if they are properly interpreted. Satisfactory results can be obtained only through painstaking effort and by the use of proper equipment and technic. Interpretation requires a thorough knowledge of the normal and at least a working knowledge of the common abnormal conditions. Experience plays an important part in interpretation, providing it carries with it

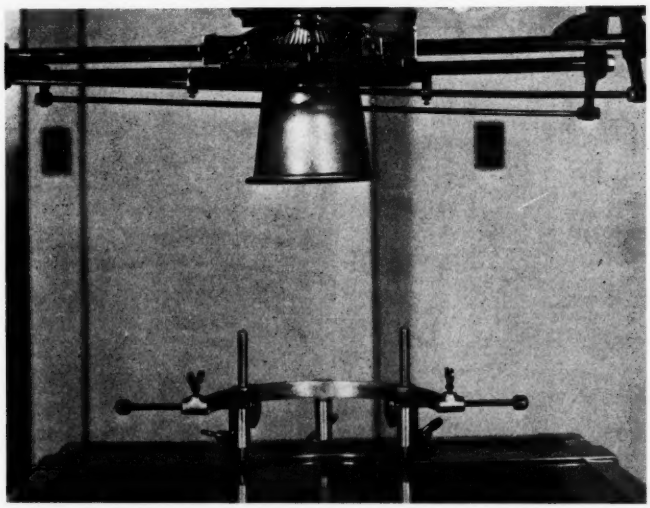


Fig. 1. Head clamp in place on table. Tube centered over center of Bucky diaphragm.

[1] Read before the Radiological Society of North America at the Eighteenth Annual Meeting, at Atlantic City, Nov. 28–Dec. 1, 1932.

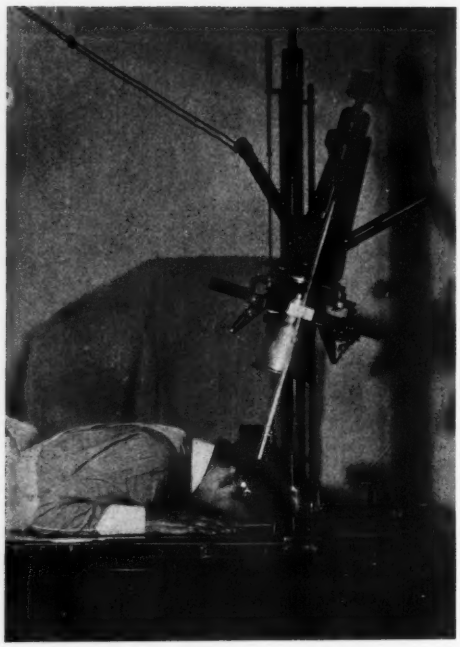


Fig. 2. Position No. 1. Visualization of frontal sinuses and anterior ethmoid cells. Tube inclined 17° from the perpendicular.

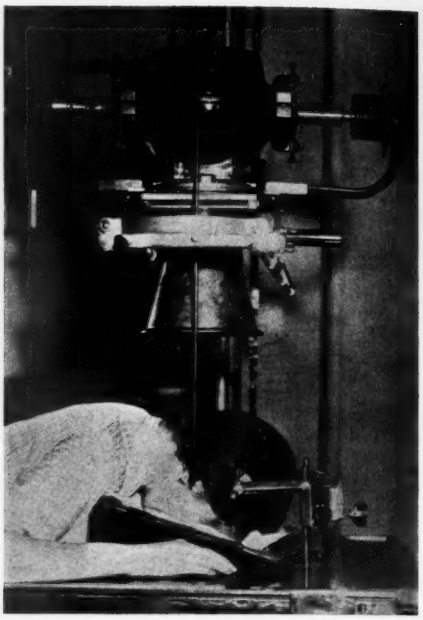


Fig. 3. Position No. 2. Granger position, 17° angle, Bucky diaphragm used.

diligent study, a reasonable basic knowledge, and careful observation of the conditions found at the operating table.

TECHNIC

The first essential is securing of technically satisfactory films, adequate in number, and made in such positions that each sinus is shown clearly with the fewest possible superimposed shadows. There are many factors which are most important if this first requirement is to be satisfied, one of the most important and an often neglected one being dark room technic. The proper dark room procedures are too well known to require repetition, but if results are to be satisfactory utmost care must be given these details.

Positions are an important consideration and the accompanying illustrations serve to show the ones used in my practice. The head clamp was designed by the writer and has two important purposes: First, that exact centering of the head in relationship to the x-ray tube and the center of the film may be easily secured, and the second, adequate fixation. Many sinus films are misleading because rotation results in apparent increase in density of some of the areas because of superimposed shadows. This clamp is simple in construction and has proven to be most valuable, not only in sinus examinations but in all examinations of the head, including encephalograms and ventriculograms.

The first position used, designated as No. 1, has for its purpose the visualization of the frontals and the anterior ethmoids. In this particular illustration the forehead and nose are down and the tube inclined 17 degrees toward the feet. The central beam is directed toward the base of the nose, a centering which is accomplished by the clamp and the pointer. In this position the above named sinuses are clearly shown. In many of my examinations, however, I use a 17-degree angle block without the Bucky

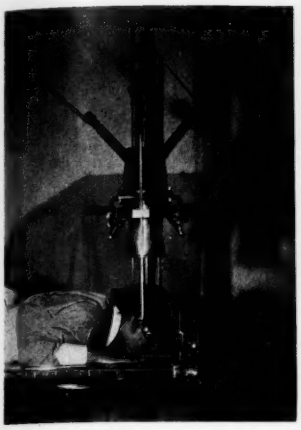


Fig. 4. Position No. 3. First stereoscopic position for antra.

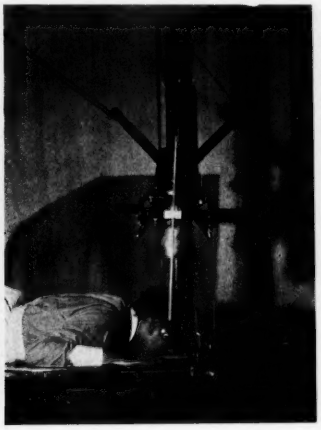


Fig. 5. Position No. 4. Second stereoscopic position for antra.

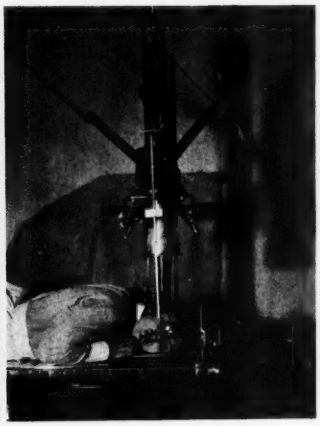


Fig. 6. Position No. 5. Lateral.

diaphragm and center the tube in the same place.

In the second position, that described by Granger, the clamp permits exact centering, while the pointer permits the direction of the central beam on a line parallel to one passing through the tragus. The Bucky diaphragm is used routinely.

The third position is essentially the Waters, and is the only one in which stereoscopic films are used routinely. It is my opinion that this is a most satisfactory position for visualizing the antra and that stereoscopic films add greatly to the accuracy of interpretation. As indicated, the tube is centered immediately over the anterior margins of the antra, and the first exposure made. The tube is then shifted toward the vertex, a distance of 2.5 inches, and the second exposure made. The tube is tilted only if the cone is small and there is danger of cutting off a part of the area that should be shown.

The fourth position is the lateral. In my experience it has little value in showing disease of the sinuses, but it does, to some extent, show the type of sinus development and may reveal easily demonstrable intracranial pathology, especially in the region of the sella turcica.

As stated above, these are the positions used routinely but certain types of abnormalities may require additional films made with the special purpose of demonstrating more satisfactorily the lesion present. The axial, or vertex submental, position is of definite value in disease of the sphenoids and posterior ethmoids and re-

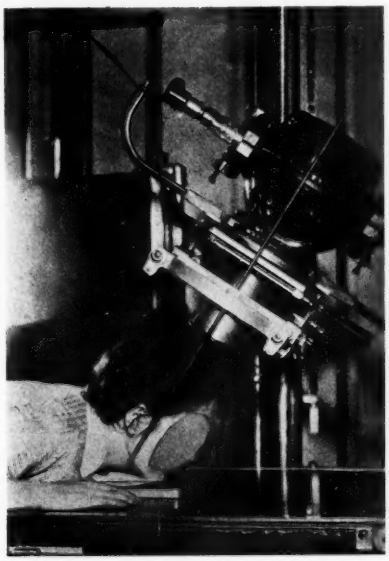


Fig. 7. Position No. 6. Vertex submental position for visualizing posterior ethmoids and sphenoids.

Fig. 8. Normal frontals and anterior ethmoids; 17° angle block; forehead and nose down; tube centered over base of nose.

Fig. 9. Normal posterior ethmoids and sphenoids shown in vertex submental position as indicated in Figure 7.

Fig. 10-*A*. Infection of right sphenoid and right posterior ethmoids shown in Granger position, with normal Granger line on the left.

cently has been used routinely in my examinations.

Another important consideration is whether or not to use the Bucky diaphragm. Personally I consider it most necessary except in films of the frontal sinuses, the ethmoids, and in the axial view of the sphenoids. It gives sharper detail, especially in the bony walls of the sinuses, and aids greatly in showing clearly the exact nature of the changes in the sinuses, especially in the antra.

The exposure technic varies with the type of equipment in use. In my work, I use a 30-inch focal distance, 50 milliamperes, a 2-second exposure, and vary

Fig. 10-*B*. Infected posterior ethmoids and sphenoids on right, and normal sinuses on left, shown in the vertex submental position, illustrated in Figure 7.

Fig. 11. Normal antra as shown by position No. 3.

the penetration between 60 and 90 kilovolts, depending upon the position.

THE USE OF OPAQUE MEDIA

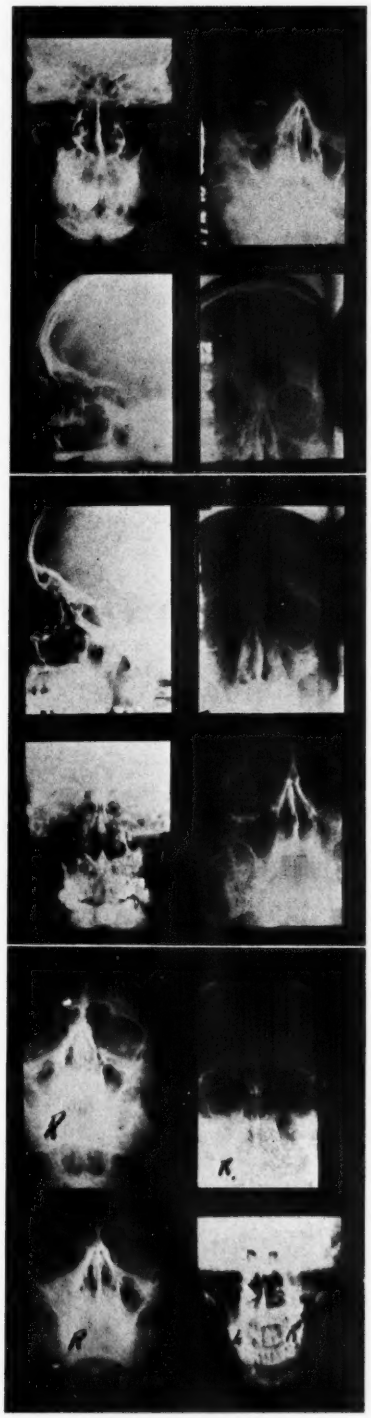
In my own experience, the use of such media has been limited to examinations of the antra. In most instances they are chiefly confirmatory in that they show in a rather striking manner changes which have already been noted in films made in the usual manner. An exception to this is in the cases in which the chief involvement is in the mucosa lining the anterior or posterior walls of the antra. In these cases unsuspected pathology may be demonstrated—and such cases are by no means uncommon.

It is best to inject only one side at a time for when both sides are injected, the conditions present may be obscured by superimposed shadows, especially in cases in which the major involvement is in the anterior or posterior aspect.

THE FRONTAL SINUSES

These sinuses are subject to marked variation in size and configuration—their density may vary due to a difference in the thickness of the walls. Normally, the margins are sharply defined. In acute infections the density is increased, due to swelling of the mucosa, the presence of pus, or to a combination of these two conditions. Not infrequently there may be an extension of the infectious process into the bone surrounding the sinus, with a resultant osteomyelitis. A purulent infection may become chronic but extensive hyperplastic changes in the mucosa are rare because of the dependent drainage. Mucoceles, osteomas, and malignant tumors are seen at times.

When these sinuses are infected there frequently is an associated infection of the antrum and anterior ethmoid cells on the

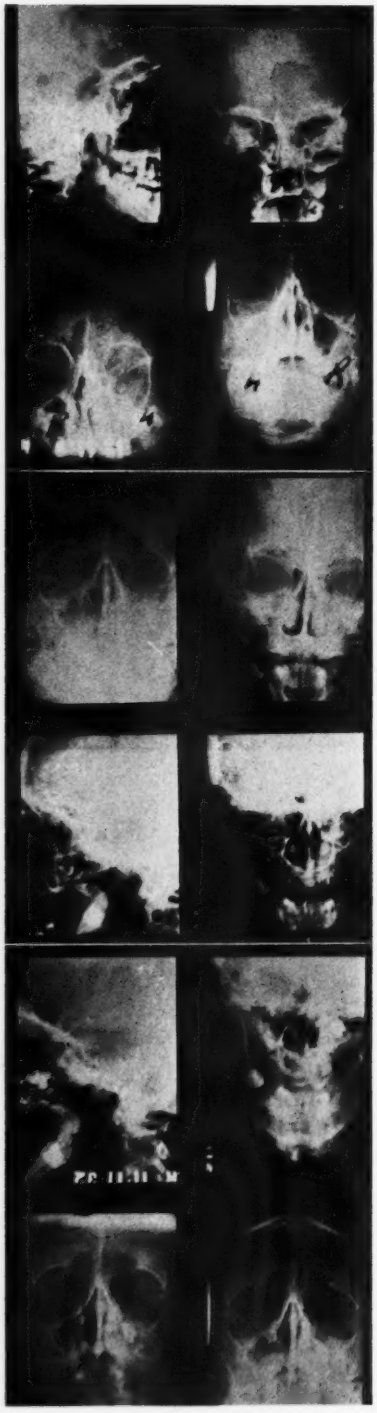


Figs. 12, 13, and 14.

Fig. 12 (*upper 4 views*). Normal sinuses. Granger sphenoid line well shown.

Fig. 13 (*middle 4 views*). Small thick-walled left antrum. Normal sinuses.

Fig. 14 (*lower 4 views*). Acute sinusitis of right frontal, anterior ethmoids, and antrum. Upper left film made after 10 days' treatment.



Figs. 15, 16, and 17.

same side, explained by the very close relationship of their areas of drainage into the nose.

THE SPHENOID SINUSES

These sinuses vary greatly in size and sometimes are seen as a single cavity, due to a partial or complete absence of the septum. This variation is important because it frequently explains the fact that the entire sphenoidal area shows evidence of infection in cases in which, otherwise, changes are limited to the sinuses of one side only. Drainage is at the upper anterior margin and as a result is not satisfactory in all positions. An acute purulent infection results in generalized increase in density of the sinus area. Resolution may take place or the disease may become chronic, with resultant hyperplastic changes in the mucosa. By the use of the x-ray it is possible to differentiate between a purulent and a hyperplastic sinusitis. In purulent disease the area beneath the roof is increased in density and the dependent margin of the roof cannot be seen, while in hyperplastic disease the roof may be broad and dense and the dependent margin lack definition.

Granger's excellent work has been most important in the demonstration and interpretation of the various abnormalities of these sinuses.

Fig. 15 (*upper 4 views*). Case 4. Acute infection of left frontal, ethmoid cells, and antrum. Anterior ethmoid cells obliterated. Child acutely ill, apparently on verge of uremia. Very rapid recovery after drainage of infected sinuses.

Fig. 16, *middle 4 views* (routine examination) and Fig. 17, *lower 4 views* (examination after lipiodol injection). History of an acute sinus infection of 3 weeks' duration (Case 5). Pain in region of left cheek for 10 days. Inspection showed large amount of pus in middle fossa. Antrum was irrigated and much pus was obtained. X-ray examination showed marked clouding of left antrum, left anterior and posterior ethmoids, the entire sphenoid area, and the left frontal. The clouding of the entire sphenoid area was attributed to the fact that the septum was probably absent. Films made after injection of lipiodol into the left antrum showed a very marked, irregular thickening of the mucosa, likely with polypoid degeneration. An opinion was expressed that this was probably an acute infection superimposed upon a chronic one. After 10 days of conservative treatment the acute infection had largely subsided. Radical operation was not done.

Infections in these sinuses frequently accompany those of the posterior ethmoids on the same side, explained by the close relationship of their openings into the nasal passage.

THE ETHMOIDS

Either group of ethmoid cells may show acute or chronic changes similar to those of the sphenoids. Hyperplastic changes in the mucosa are common, as are polyps. Infections of the anterior cells often accompany infections of the antra and frontals.

In the x-ray film, disease is manifest by an increase in the density of the sinus area. In acute disease this increase is homogeneous but in hyperplastic disease there may be increase in the density of the walls of the cells, together with a lack of definition. In some instances the changes may be osteolytic in nature and the cell walls may be less dense than normal or may largely disappear.

Figs. 18 and 19.

Fig. 18 (*upper 4 views*). Case 6. Purulent infection of left sphenoid. Patient complained of pain in region of left eye radiating to the occipital area during a period of one year. The pain was more severe in the morning and less troublesome in the afternoon. Transillumination and other clinical examinations were entirely negative. The left antrum was irrigated and fluid returned clear. The left sphenopalatine ganglion was cocanized with some relief. X-ray examination showed definite clouding of the left sphenoid and no evidence of involvement of any of the other sinuses. A diagnosis of a left sphenoid sinusitis was made. This sinus was irrigated through the natural opening and a cast of pus approximately six inches in length was washed out. The diameter of the cast was exactly that of the opening into the sinus. Irrigations were repeated upon three occasions until the fluid returned clear. The patient has had complete relief from symptoms since that time.

Fig. 19 (*lower 4 views*). Case 7. Extensive mucosal thickening and polypoid degeneration, right antrum. Routine films and others after lipiodol injection. Patient experienced an attack of pain in the region of the right eye radiating to the right occiput, in October, 1930. At that time the sphenopalatine ganglion was cocanized and a refraction error in the eye was corrected. This resulted in relief. After a short period however, the patient again began to experience pain in the right antrum. In February, 1932, this became acute for a period of one week. At that time pus was washed out of the right antrum. X-ray examination was done March 7 and I reported evidence of very extensive hyperplastic changes in the mucosa lining the antrum. I also stated that there probably had been an infection of the ethmoid cells and right sphenoid at some time. There was no evidence of pus in the sphenoid at the time of the examination. Lipiodol injection confirmed the opinion that there were very extensive hypertrophic changes in the mucosa lining the right antrum and it was further stated that numerous polyps probably were present. A Caldwell-Luc operation was done upon the right antrum. The operation revealed very marked, firm thickening of the mucosa of the antrum, with extensive fibrosis and degeneration. A microscopic examination of the tissue removed from the antrum was reported by a pathologist as chronic inflammation, mucosal degeneration, fibroid polyposis. This patient has been entirely free from symptoms since the operation.

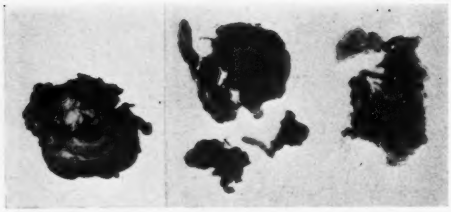


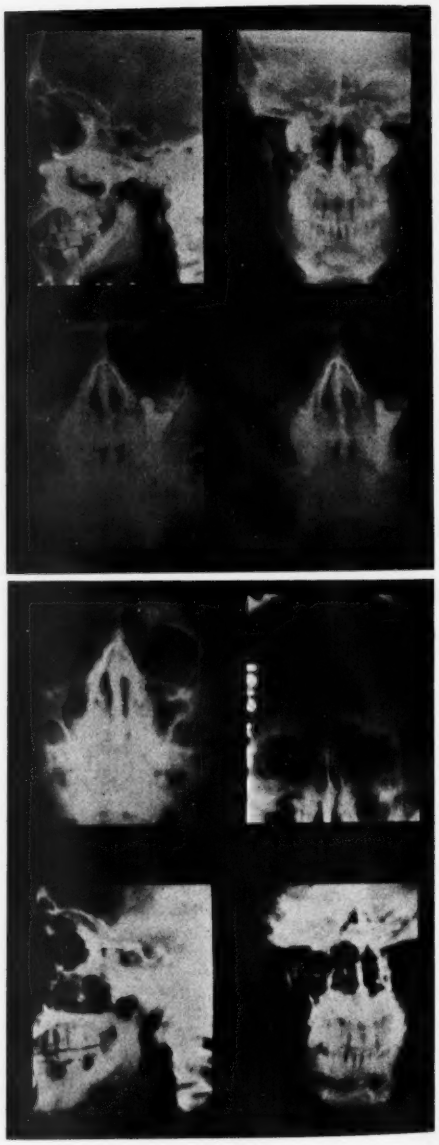
Fig. 20 (*left*). Case 7. Hyperplastic tissue removed from antrum.
Fig. 21 (*right*). Case 8. Hyperplastic tissue removed from antra.

THE ANTRA

In acute infectious disease there usually is a homogeneous increase in the density of the antrum involved, due to swelling of the mucosa, the presence of pus, or both. If the mucosa is swollen, the inner margin of the thickened mucosa can usually be seen and it is likely to be regular and defined with fair sharpness. This is usually true also of allergic swelling without infection.

Drainage of the antra is not very satisfactory because the openings into the nose are at the upper medial aspects, and because of this, at least partly, chronic changes are common. These usually are manifest by hyperplasia of the mucosa, often followed by polypoid degeneration.

In an x-ray film the hypertrophied mucosa is shown by a shadow extending inward from the bony wall of the antrum. In a chronic active infection the inner margin of this shadow is likely to be irregular and indefinitely defined, but in cases in which the shadows are due to an old fibrosed mucosa the margins are dense and



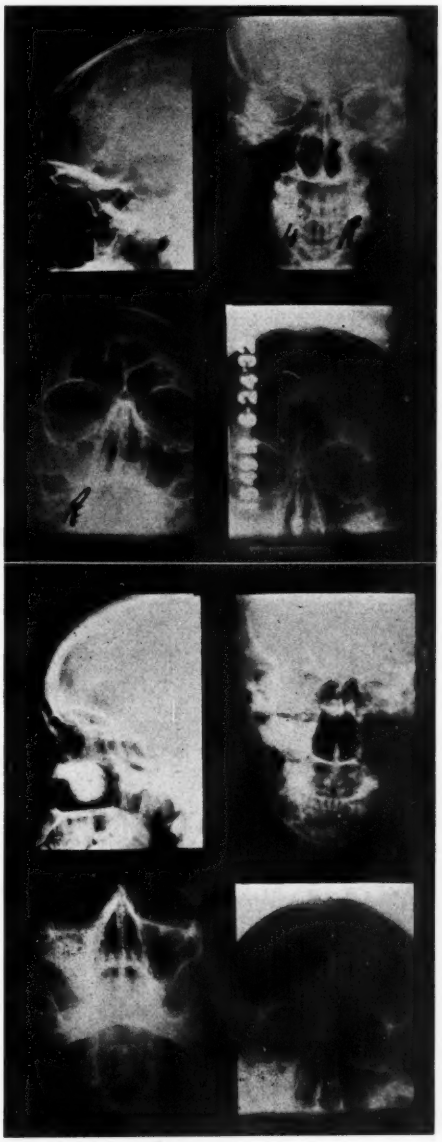
Figs. 22 and 23.

Fig. 22 (*upper 4 views*). Case 8. Routine films
Fig. 23 (*lower 4 views*). Case 8. Films made after lipiodol injection. Patient experienced acute attack of pain in left side of head 13 years ago Had a similar attack 9 months later. These attacks recurred at intervals of about two or three months after that time. Polyps were removed from the nose two years ago. Others have been removed at intervals since; pain continued at intervals. Nasal examination showed polyps in the middle meatuses. Transillumination was essentially negative. Irrigation showed some old pus in the antrum.

X-ray examination (Oct. 7, 1932) showed evidence of extensive hyperplastic changes in the mucosa lining both the antra, together with evidence of changes resulting from infection in the ethmoids and sphenoids. Lipiodol injection was done and the films showed a large irregular filling defect in the floor of the right antrum considered to be characteristic of changes resulting from hypertrophy of the mucosa, together with polyps. Similar, but less extensive, changes were noted on the left. A bilateral Caldwell-Luc operation was done and marked hypertrophic changes in the mucosa of the antra, with polypoid degeneration, were found. Intranasal operations were done on the ethmoids and sphenoids and changes similar to those in the antra were found. The patient has been without symptoms since the operations.

sharply defined. Polyps are seen as irregular shadows of varying sizes projecting inward from the margins and are found in any part of the antrum, especially the floor and lateral aspect. An antrum filled with pus as a result of chronic disease cannot be differentiated from an acute infection and is usually not associated with extensive changes in the mucosa.

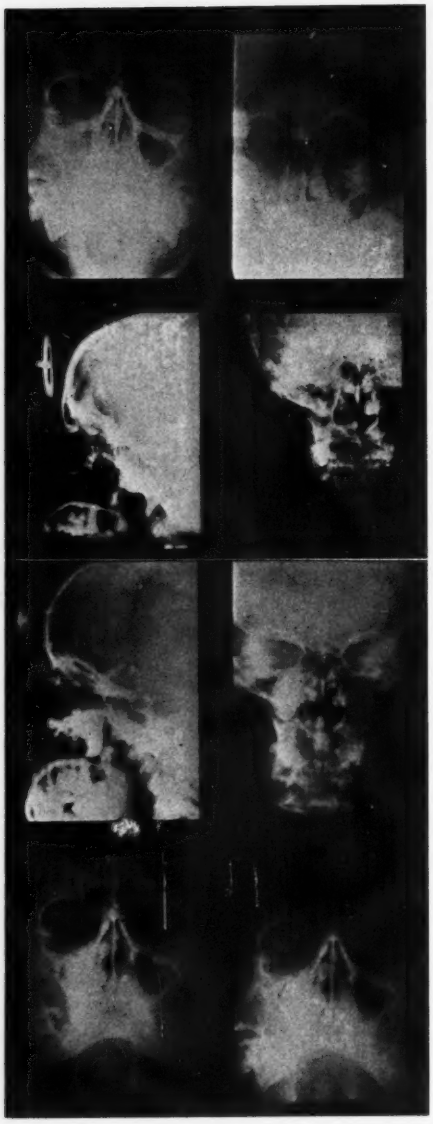
Maxillary cysts may resemble polyps, making it difficult to determine their true nature without the use of an opaque medium and a dental examination. The so-



Figs. 24 and 25.

Fig. 24 (*upper 4 views*). Case 9. Recurrent sinusitis of right antrum after radical operation, apparently reinfected by drainage from right ethmoids and frontal. This patient had first symptoms of sinus disease in 1928, at 14 years of age. Onset took place after swimming, being characterized by pain over right eye. Examination at that time showed infection of the right antrum, right anterior ethmoid cells, and right frontal, confirmed by x-ray examination and transillumination. Symptoms subsided in ten days. There was a recurrent attack nine months later, at which time the antrum seemed chiefly to be involved. An intranasal window was made into the right antrum in June, 1929. This window closed rather promptly and the patient had a recurrence of symptoms in December, 1929. In July, 1930, a Caldwell-Luc operation was done upon the right antrum. In November, 1930, a reinfection took place in the right antrum and at that time purulent drainage was found coming from the right anterior ethmoid cells and the right frontal. In February, 1931, a very large window was made into the antrum and a rubber drain was left in place for five days. Improvement followed, but in February, 1932, the patient began to have symptoms again. In June, 1932, an x-ray examination showed some increase in the density of the right frontal and the right anterior ethmoid area. There was very marked increase in the density of the right antrum and at that time an opinion was expressed that the increased density of the antrum was evidently the result of a longstanding infection, probably with marked thickening of the mucosa and polypoid degeneration. In July of this year a Caldwell-Luc operation was done on the right. The anterior wall of the antrum was found to have regenerated after previous operations. The mucosa was found to be greatly thickened and polypoid degeneration was present. July 19 a Lynch external ethmofrontal operation was done. Evidence of chronic inflammation was noted in the mucosa lining the frontal sinus and hyperplastic changes, together with polyps, were found in the ethmoids. This patient has been free from symptoms since the last operation.

Fig. 25 (*lower 4 views*). Case 10. Anterior filling defect due to polyps and hyperplastic changes in mucosa. Patient experienced pain in region of right cheek, radiating over right eye, more or less constantly for a period of one year, aggravated by colds. Examination of the nose was essentially negative. The right antrum was irrigated and the fluid returned clear. Transillumination was negative. The routine films showed evidence of very slight thickening of the mucosa in the right antrum. Lipiodol injection was then done. Films made in the postero-anterior position were essentially negative. However, stereoscopic films were made in the right lateral position and they showed a large filling defect in the anterior inferior aspect of the right antrum, evidently the result of extensive hypertrophic changes in the mucosa. Operation revealed a large polyp extending out from the anterior and inferior portions of the wall of the right antrum. The mucosa lining this portion of the antrum was hyperplastic but was limited to this region. The patient has had complete relief since operation, which was done more than a year ago.



Figs. 26 and 27.

Fig. 26 (*upper 4 views*). Case 11. Marked increase in density of right antrum. Curved upper margin indicative of large polyp.

Fig. 27 (*lower 4 views*). Case 11. Filling defect after lipiodol injection. Operation revealed large polyp growing from anterior inferior wall. Hyperplasia of the mucosa limited to that area.

called follicular cysts may have teeth in them which will aid in the diagnosis.

The antra may vary in size and the difference in density may be misleading unless films are made stereoscopically.

GENERAL CONSIDERATIONS

Tumors—benign or malignant—may involve any of the above sinuses. They may be mistaken for changes resulting from infection. In malignant tumors, bone destruction suggests the true nature. Traumatic disturbances may involve the sinuses; the walls may be fractured; there may be hemorrhage into the sinuses and often secondary infection follows. Infections of any of these sinuses may extend into the surrounding bony walls, an osteomyelitis may result, and an infected sinus may rupture into any of the surrounding areas.

Sinusitis is a frequent complication of many acute infectious diseases, especially influenza, scarlet fever, and measles. The incidence is high in pulmonary tuberculosis and it may be a serious complication in diabetes. True tuberculous and syphilitic infections of the sinuses take place but are relatively rare. Sinusitis is found frequently in the presence of bronchiectasis, certainly aggravating the condition in the chest, and it may well be a causative factor in the onset of the disease.

THE ROENTGENOLOGIST'S REPORT

This report should include a description of the conditions noted in each sinus, including variations in size and in the thickness of the walls. The latter is especially important in the antra, for variations in size and thickness may add to the difficulty of operation unless they are recognized. The report should give a detailed interpretation of the significance of the various findings and should state what abnormalities are thought to be present. If this is done, the roentgenologist will render a real service to the physician referring the case and will be accorded his proper place as a consultant.

DISCUSSION

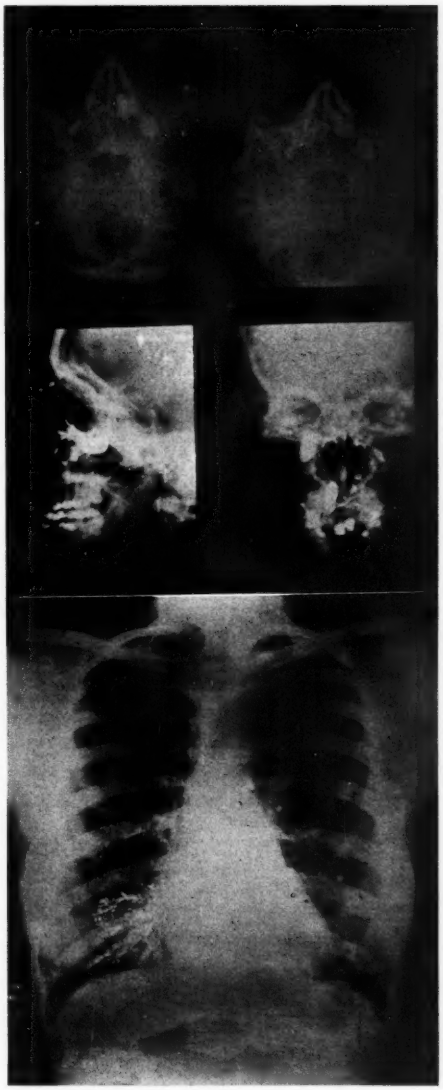
DR. MORRIS E. NEWMAN (Buffalo, N.Y.): Although not a member of your Society but enjoying its privilege through the courtesy of one of your members, I should

like the opportunity to say a few words on Dr. Bell's paper from the angle of the otolaryngologist.

I have been interested for a good many years in the relation of bronchiectasis and sinus infection, and it is my opinion that every case of bronchiectasis has or has had an ethmoid infection, and many cases have an associated infection in the maxillary antrum.

Lipiodol injection is coming into more common use in diagnosis of chronic sinus disease. I should like to question the speaker as to whether he instills the lipiodol himself or has it done by a nose and throat specialist—whether the antra are washed out prior to the instillation of the oil or whether the oil is put in through the normal antrum orifice. I think the picture as seen following an antrum wash with lipiodol injection differs from the picture as seen in a case in which the oil has been injected into a sinus not previously irrigated.

In reference to the question of transillumination by the rhinologist for diagnosis of sinus infection, I think we are getting farther away from forming our opinion on transillumination alone, especially in cases of thickened bone and old chronically thickened membranes, and are referring our cases to the x-ray specialist and depending more on his interpretation of the sinus plates, in conjunction with our clinical findings, and disregarding transillumination as an important adjunct.



Figs. 28 and 29.

Fig. 28 (*upper 4 views*). Case 12. Extensive hyperplastic sinusitis in patient with definite bilateral bronchiectasis. Chest symptoms have almost entirely disappeared since radical operation on antra and intranasal operation on ethmoids.

Fig. 29 (*lower 4 views*). Case 12. Lipiodol injection showing cylindrical type of bronchiectasis in right lower lobe. Condition is evidently bilateral.

LÜCKENSCHÄDEL OF THE NEWBORN

By HOWARD P. DOUB, M.D., *and* JOSEPH T. DANZER, M.D., *Department of Radiology, Henry Ford Hospital, Detroit, Michigan*

ABOUT a year ago a newborn baby was referred to us for roentgen examination of the skull and spine. The clinician reported that the skull bones felt as if they could be molded slightly, and that there were soft spots present over the head. There was also an extensive spina bifida, with meningocele, present. Roentgen examination revealed numerous lacunæ, with bony ribs surrounding them, throughout the skull. There was also an extensive spina bifida present. On searching the literature no description of this syndrome could be found in English but it was adequately described in the German literature. Recently an excellent description of this anomaly was given by Kerr (8) in the "American Journal of Roentgenology and Radium Therapy."

Various names have been applied to this condition by authors writing on the subject. It has been called "relief skull," "lacuna skull," and "Lückenschädel." Throughout this communication we will use the term "Lückenschädel," as originally given by Engstler (2).

In 1875, James F. West (15) described a case of spina bifida, with meningocele, in the cervical area. Associated with the spinal condition were small defects which occurred throughout the vault of the skull. This is the first description of a case presenting associated defects in the skull and spinal column. A little later von Recklinghausen (14), in discussing spina bifida, described two cases which had associated skull defects, apparently examples of this condition. In 1903, Heubner (4) discussed the fact that in cases of spina bifida one frequently finds associated defects in the cranial bones and reported a case of spina bifida and club feet, with very marked skull changes. Perhaps the most complete article on the subject is one by Engstler (2), which appeared in 1905. He made an extensive survey of the literature and collected 12 cases. The inclusion of some of these cases is questionable, however, owing to incomplete autopsy reports. He gave an excellent description of the condition and noted the association of the spinal and cranial defects. After studying Engstler's (2) cases, Wieland (16) decided that two different types of cases were represented in his report—one, the condition under discussion, and the other a simple apposition defect. One of the most complete studies of this condition was reported by Faust (3) in 1931. He described in great detail the gross and microscopic pathology represented, and also discussed thoroughly the various theories relating to the etiology.

The appearance of the skull does not show a characteristic deformity. There is a tendency in most cases, however, toward hydrocephalus, although skulls of normal appearance have been described and even two cases of microcephaly. Upon palpation the skull feels plastic, as though it could be easily molded with the hand, and there may be numerous small soft areas felt throughout the vault of the skull. The sutures may be widely separated. These cases of skull deformity have an associated spina bifida or encephalocele.

The roentgen film discloses an abnormal calcification of the bones of the vault of the skull, a calcification which occurs in the form of bony ribs which inclose sharply outlined, rounded or oval-shaped areas of radiolucency due to a lack of calcification. This gives the skull a honey-combed (Schinz, 11) or net-like appearance which is characteristic of the condition. These bony ribs are inclined to have a rather dense, eburnated appearance, accentuated by the areas of lessened density surrounding them. Associated with the skull changes

is found the typical appearance of spina bifida, with meningocele. Encephalocele may also be seen.

On postmortem examination the outer layer of the cranial bones is found to be smooth to the touch. The cranial defects are covered by a stout parchment-like membrane or a thin layer of bone. The inner table of the skull presents a different picture: a rough and irregular surface, with many interlacing beams of bone between which are round or oval depressions or lacunæ. These lacunæ measure from 0.5 to 2.5 centimeters in diameter and vary from a slight depression in the inner table to a complete penetration through the skull bone. Faust (3) made a comprehensive gross and microscopic study of the cranial bones of one of these cases and states that these bony beams are hard, thick, and rich in blood vessels.

There is a sharp disagreement among different authors in regard to the etiology of this condition, the most common theory being that of a pressure disturbance. This is supported by such writers as von Recklinghausen (14), Faust (3), Wieland (16), Schüller (12), Schinz (11), and others. Von Recklinghausen (14) believes that the condition may exist as the result of anatomical defects, but states that it may begin as a meningeal hydrops which produces an increased pressure of the spinal fluid and causes a herniation of the spinal canal. Faust (3) believes that there is increased intracranial pressure, and that the meningocele or encephalocele acts as a tension valve for the subarachnoid fluid. He believes that the cleft formation of the medullary tube is of primary importance and the malformation of the skull the result of this. Wieland (16) states that the circumscript erosions are explained through the mechanical action of increased pressure. Because of the especially rapid growth of the brain at this age, the lateral portions of the skull arch are undeveloped and, therefore, the skull is more susceptible to the formation of defects at this time from the influence of increased pressure.

Fig. 1 (Case 1). Photograph showing meningocele.

Engstler (2) opposes the theory that increased pressure is the etiologic factor in this condition. He believes that there is occlusion of the vertebral artery, with a consequent lessening of blood supply to the cranial bones, the latter condition interfering with their normal calcification. According to this author, it is a condition primarily of maldevelopment.

Cohn (1) does not believe that these defects can be accounted for by mere mechanical pressure, but are the result of

delayed development or calcification of the cranial bones. He states that he has seen such deformities in infants who are otherwise normal.

The roentgen appearance of Lückenschädel is unlike the appearance seen in most other skull conditions. It must be differentiated from the soft skull apposition defect described in detail by Wieland (16), who states that the latter defect is due to the fact that during the last few months of pregnancy the brain grows so fast that the membranous portion of the skull is expanded and the calcification process is unable to keep pace with the rapid expansion of the skull. The baby is born with the edges of the skull bones uncalcified, showing soft skull apposition defects. This is a physiological process, however, and soon changes to normal calcification. In 1921, Hughes (5) reported a series of cases which he called "craniotabes." He states that craniotabes, arising during the first few months of infancy, is only a fresh manifestation of fetal atrophy already existing in late fetal life. He attempts to differentiate fetal rickets, or craniotabes, from the soft skull defect of Wieland (16), but does not mention Lückenschädel. The appearance of the illustrations accompanying this article is such as to strongly suggest that they are cases of what we call Lückenschädel.

In this connection skull defects seen in Schüller-Christian's disease would have to be considered, but the clinical features of this disease are sufficient in themselves to make the differential diagnosis.

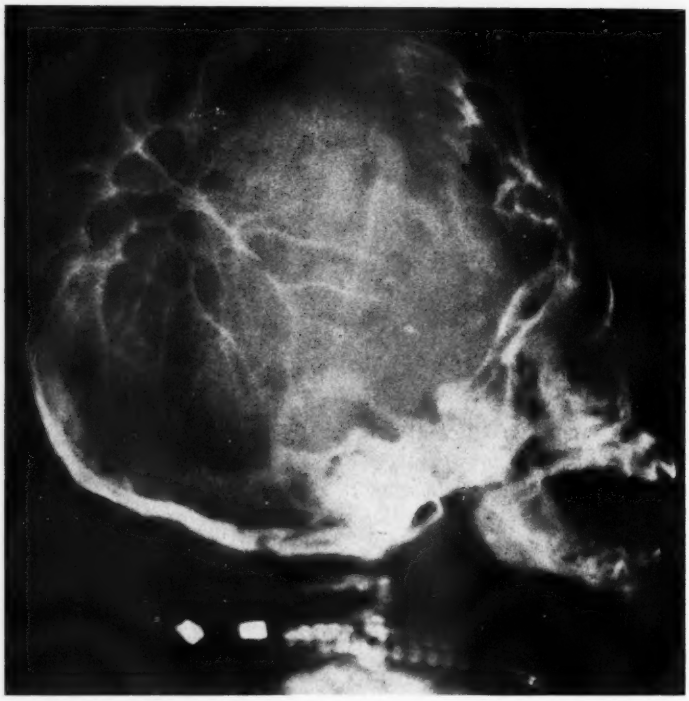


Fig. 2 (Case 1). Bony ribs enclosing lacunæ. Typical appearance of Lückenschädel.

CASE REPORTS

Case 1. W. T. R., white male, born Dec. 16, 1932; vertex presentation; Wassermann negative. There was normal delivery, and the child cried promptly. Birth weight, 4,050 grams; length 54 centimeters. Diameters of head: occipito-mental, 16 cm.; occipito-frontal, 11.5 cm.; suboccipito-Bregma, 10 cm.; biparietal, 1.5 cm.; bitemporal, 8.5 cm.; suboccipito-Bregma circumference, 34 centimeters. At birth it was noted that the appearance of the face and forehead was similar to that of a Mongolian idiot. The spina bifida and skull abnormality were noted at that time. One other child of same parents is living and well.

Later examination disclosed a soft, easily molded skull which felt like parchment, and there were numerous soft places distributed over the head. There was a large spina bifida, apparently extending from the sacrum to the skull as no spinous processes could be felt, and there was a double line of bony ridges to either side of the mid-line. There was also a myelomeningocele in the lumbar area. There were bilateral club feet. The sphincter action was normal, there was a congenital heart lesion, and the general muscle tone was lowered. The child cried vigorously, with even the slightest movement of the bed, suggesting that movement caused pain. The progress of the child was continuously downward and it expired Dec. 29, 1932. Permission for an autopsy was refused.

Roentgen examination of the skull shortly after birth revealed that the lacunæ were surrounded by the bony ribs which are so characteristic of Lückenschädel. There was also the accompanying spina bifida, with meningocele in the lumbar area. There was no bulging of the sutures.

Case 2. Stillborn white female, born May 9, 1924; breech presentation; Wassermann negative. Because of a marked hydrocephalus, which was diagnosed previous to delivery by means of x-ray examination, a catheter was inserted into the cranial cavity and 875 c.c. of cerebrospinal fluid was drawn off, after which the child was delivered spontaneously. A large spina bifida, with meningocele, was present in the dorsal region. Weight, 2,515 grams; length of body, 46 centimeters. Head measurements: occipito-mental, 17 cm.; occipito-frontal, 15.5 cm.; suboccipito-Bregma, 14 cm.; biparietal, 13.5 cm.; bitemporal, 8.75 cm.; suboccipito-Bregma circumference, 44 cm.; greatest circumference of head, 47 centimeters. One other child of the same parents is living and well at the age of five years.

The tissues were removed from the skeleton, which was kept as a museum specimen. Examination of this skeleton reveals a large hydrocephalus with multiple small rounded areas, in the frontal region, which are devoid of bone. These openings in the bone are covered by a stout parchment-

Fig. 3 (Case 1). Anteroposterior projection of skull shown in Figure 2.

like membrane which shows no evidence of bulging. The bone surrounding these openings does not appear to be thicker than normal and does not show the rib-like formation usually seen in Lücken-

Fig. 4 (Case 2). Photograph of fetus showing hydrocephalus and meningocele.

schädel. The spine shows an extensive spina bifida throughout and in the dorsal area there are marked congenital deformities of all the vertebræ, with corresponding deformities of the ribs.

Two years later the mother gave birth to another stillborn child which had an extremely large encephalocele.

DISCUSSION

One of the most interesting features of this condition is the question as to its etiology. There are many theories as to

Fig. 5 (Case 2). Photograph of dried skull of fetus showing hydrocephalus and bony defects in frontal areas.

the probable cause of its occurrence and, for the sake of convenience, we have classified them under the following headings: (1) The theory of pressure disturbance; (2) the theory of congenital growth disturbance, and (3) the theory of deformity due to disease.

The majority of the writers on this subject, as we have already mentioned, appear to favor some type of pressure theory. Some of the arguments advanced to support this theory appear to us as rather fanciful. It would seem that if pressure is to be considered as the main factor in the production of this deformity of the skull, it could best be explained by the action of internal hydrocephalus. It is a well known fact that in persons who have

increased intracranial pressure we see evidence of convolutional atrophy of the inner table of the skull. The skull bones of cases presenting increased intracranial pressure and those of Lückenschädel show somewhat similar characteristics inasmuch as both have irregularity of the surface contour of the inner table of the skull and a smooth outer surface. If this amount of bony change can be produced in an adult skull by increased pressure, it is easy to suppose that a much more marked change could be produced by pressure on incompletely formed skull bones undergoing calcification. Some support is given to this theory by our second case, reported above, which developed marked hydrocephalus *in utero* and which, while not presenting the typical bony changes seen in Lückenschädel, still shows similar bone defects in the frontal area. This case also showed extensive congenital deformity of the spine, with rachischisis.

It must be remembered that spina bifida, with an accompanying myelomeningocele or syringomyelocele, is always present with this skull deformity and that demonstrable hydrocephalus is present in a high percentage of the cases. It is a well-known fact that, if the sac of a myelomeningocele is removed in an attempt to repair this condition, the child will always develop a hydrocephalus. Penfield and Cone (10) have shown that if the sac is folded in, and not removed, when the operation is performed, hydrocephalus will not occur. The presence of hydrocephalus in a high percentage of these cases, together with myelomeningocele, would lend some weight to the theory that increased pressure does play some part in the etiology of this condition.

A number of writers favor the theory of a congenital growth disturbance. Cohn (1) believes there is a delay in the rate of calcification of the cranial bones, and he states that he has seen similar changes in otherwise normal infants. Von Recklinghausen (14) and Engstler (2) describe blood vessel changes resulting in lessened blood supply to the cranial bones, with interference in their normal calcification. They believe these changes are fundamentally of a congenital nature.

It is well known that congenital deformities are exceedingly apt to be multiple in the same individual, just as we have here deformities of the skull, spine, and feet. An example of a similar multiple lesion which might be quoted is anencephaly, with skull and spine deformities, which has enough points of similarity to suggest a similar etiology.

The theory of a disease process being the causative factor in this condition should be mentioned. Hughes (5), in 1921, gave his conception of craniotabes. He believes that craniotabes of infancy is only a fresh manifestation of a state of fetal atrophy already existing in later fetal life. He quotes Wieland's (16) work but does not mention the term Lückenschädel. The illustrations accompanying Hughes' article appear to show changes identical with those seen in Lückenschädel, although he calls them "craniotabes." He states that craniotabes may be caused by either rickets or syphilis.

Syphilis has been mentioned by various writers as the causative factor in Lückenschädel, but in the reported cases, in which complete studies have been made, the Wassermann report of the mother has been negative. This evidence, although not conclusive, suggests that syphilis does not play a part in the etiology of this condition.

SUMMARY

I. The syndrome of Lückenschädel, consisting of alterations of calcification of the skull bones, combined with meningocele or encephalocele, is described.

II. A typical case of this syndrome is reported.

III. The etiology is not known but the theory of fetal increased intracranial pressure seems the most plausible and has the largest number of supporters in the literature.

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AUTOMATIC TEMPERATURE REGULATION FOR THE X-RAY DARK ROOM SOLUTIONS

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MANY x-ray dark rooms have no scientific method of control of the temperature of the solutions and wash tanks: a few are not even equipped with thermometers. So the question arises, "What difference does it make?" The answer to this question may be found in such works as that of R. B. Wilsey.[1] He has shown that there is a range of exposure and development time giving the best radiograph, and that outside of this range the quality is distinctly inferior. The degree of development depends not only upon the time that the film is in the developer, but also upon the temperature of the latter. Thus a density reached by five-minute development at 65° F. would also be reached by 6.9-minute development at 60°, 4-minute at 70°, 3-minute at 75°, and 2.2-minute at 80°. Therefore, if uniform development is desired the temperature of the solution must be measured and the development time estimated from this. If the temperature control is not automatic, constant attention must be paid to the details of development. Uniform development results in a better quality of radiograph and also permits and encourages a more uniform exposure technic. There are other reasons why development should be carried out at a temperature near 65°. For example, the emulsion swells excessively in solutions that are too warm, and then becomes soft. The swelling due to excessive temperature may give rise to a grainy appearance of the film and the softening makes the emulsion very susceptible to pressure and scratches. The temperature of all of the solutions should be approximately the same or the emulsion may be damaged when the film is transferred from one tank to another. Where temperature control is not employed, the temperature of the wash tank is especially apt to be considerably different from that of the other solutions.

A few different methods of temperature control are described below. Installations for this purpose vary in size and cost, but each requires: (1) a method of cooling; (2) a source of heat, and (3) an automatic switch with solenoid valves.

Method I.—Employing compressor with cooling coils, hot water coils, solenoid valves, and double throw Mercoid switch (Fig. 1).

Water regulating the temperature of the solutions enters the dark room from a conditioning tank (Fig. 1). This is a large tank of about a hundred gallons capacity containing two copper coils *A* and *B*, an inlet pipe at the top, and an outflow pipe extending down to the bottom. The tank is surrounded by a good heat-insulating material such as cork or hair felt. The copper coil *A* is made of tubing $^1/_2$ inch inside diameter and about three hundred feet long, bent or wound in helical form. The coil *B* is made of 200 feet of the same size tubing, wound in a similar manner.[2] One of these coils, *A*, is connected to a refrigeration compressor *R*, run by a one horsepower motor *O*. Methyl chloride from this compressor expands in this coil upon passing the expansion valve at *X*. Its temperature is thus lowered and it absorbs heat from the water in the conditioning tank. This heat, together with that produced in compressing the gas, is removed by a water-cooling system, such as a water jacket, represented by *C*. The water running through this jacket may be controlled manually by the valve *D*, or automatically by the solenoid valve *E*.

[1] The Laws of the Development of X-ray Films. RADIOLOGY, September, 1925.

[2] Recent experience indicates that 100 feet of $^3/_4$ inch inside diameter copper tubing would be better.

The other coil, *B*, is connected to a hot water line and functions when the temperature of the incoming water, as indicated by *J*, is below 65° F. The water from the conditioning tank is conveyed to the dark room through heat-insulated pipes. By regulating the action of the refrigeration coil, or the hot water coil, the temperature of the water leaving the conditioning tank is brought to the proper point. This is accomplished by the use of a double throw Mercoid switch. The Mercoid switch consists of a metal bulb (the type known as "extra long bulb" should be used) connected through a small tube to a pressure drum arrangement. The bulb contains a fluid which volatilizes. When the temperature of the water in which this bulb is immersed, rises to a certain height, the pressure increases in the bulb. This tilts a glass tube partially filled with mercury. The mercury, falling to the lower end of the tube, closes the circuit between two electrodes sealed in the glass. This actuates the motor relay which starts the motor *O* and compressor *R*. The compressed gas expanding in coil *A* cools the water in the conditioning tank. When the temperature of the water in the conditioning tank falls below a predetermined value, the pressure in the Mercoid bulb decreases. This tilts the mercury tube in the opposite direction, breaking the electrical contact between the electrodes sealed in the glass, thus stopping the motor and compressor. A second mercury tube, similar to the one described, but with contacts in the opposite end, is fastened alongside of the first one so that the two tilt together. In this way, one opens its contacts when the other closes them. The latter actuates the solenoid valve *G*, allowing hot water to circulate through the coil *B* and heat the water in the conditioning tank.

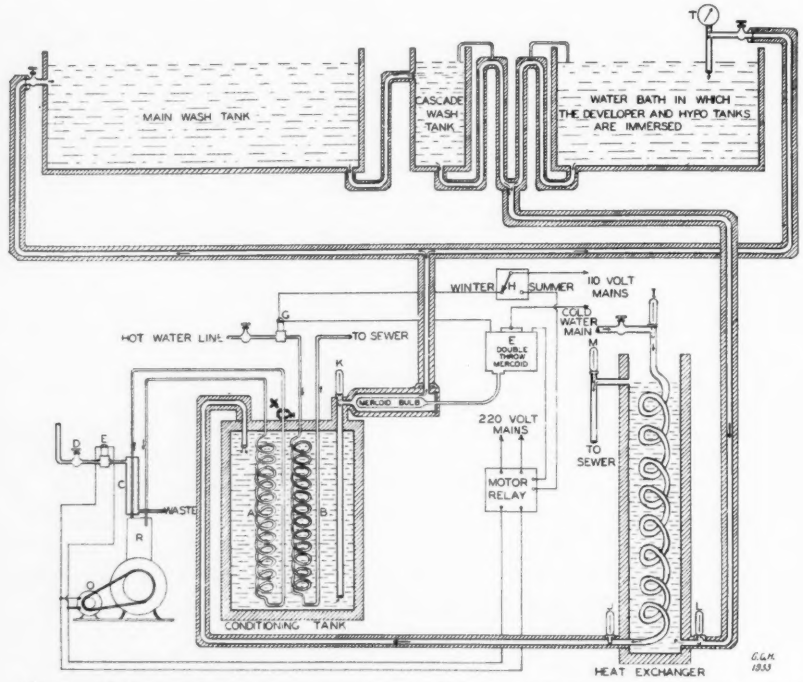

Fig. 1. System employing compressor with cooling coils, hot water coils, solenoid valves, and a double throw Mercoid switch.

In order to prevent the heating and cooling coils from operating in rapid suc-

cession due to small unavoidable fluctuations in temperature, a double throw switch, *H*, is installed as shown. It is necessary to throw this switch at least twice a year, once to the heating side for winter operation, when the temperature of the incoming water is below 65° F., and again in the summer to the cooling side when this temperature rises above 65°. By means of another Mercoid switch with its bulb in the cold water main, this change-over could be made automatic, but this is an additional expense and is not desirable because the compressor requires attention after shutting down for the winter and before starting up for the summer. The water from the conditioning tank enters the dark room and flows past an immersion bulb dial thermometer, *T* in Figure 1, which indicates to the dark room technician the temperature at all times. The water flows into a large tank in which the developer and hypo containers are immersed. The films may be rinsed in this tank between the developer and hypo immersions. Water from the conditioning tank also flows into the main wash tank where the final washing is done. The outflow goes from here into a cascade wash tank where films from the hypo bath are given a preliminary washing before being placed in the main wash tank. The outflow from this cascade wash tank, together with that from the water bath in which the developer and hypo tanks are immersed, is conveyed in a heat-insulated pipe to the heat exchanger and from there to the sewer.

The heat exchanger consists of a large heat-insulated tank about 12 inches in diameter and 5 feet high in which is placed a coiled copper tube (150 feet of $^5/_8$ inch tubing), as indicated in Figure 1. Water from the cold water main enters the upper end of this coil and goes out through the lower end to the conditioning tank. In its passage through the heat exchanger the incoming water in the coil is brought to nearly the desired temperature of 65° F. by the waste water from the dark room. This, of course, economizes on the work done by the conditioning tank. It is obvious that in order to obtain the maximum possible help from the heat exchanger, it is necessary that the waste water from all tanks be conducted to the exchanger through heat-insulated pipes (compare Fig. 1). Under these circumstances, the volume flow of waste water is equal to that of the incoming tap water.

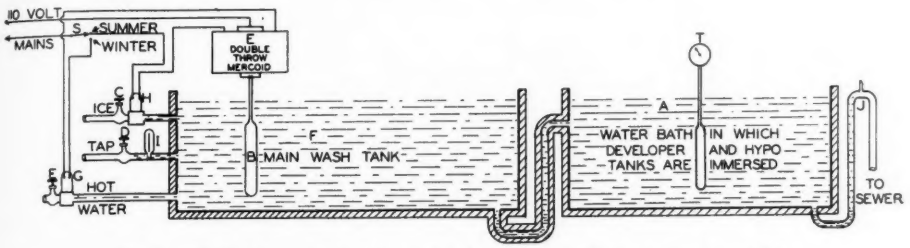

Fig. 2. Method for use where ice water, tap water, and hot water are available.

Thermometers may be put at such critical points as *J*, *K*, *L*, and *M* to check the functioning of the system but these are not necessary. The system is entirely automatic except for the summer-to-winter change-over. The best location for the equipment is in the basement below the dark room, the space required being about 4 × 8 feet floor space by $7^1/_2$ feet height.

Method II.—Where ice water, as well as tap water and hot water, is available (Fig. 2).

In this installation the incoming tap water is mixed with hot water or with ice water, depending upon whether or not its temperature (as indicated by *I*) is below

or above 65° F. The mixing occurs in the large tank, *F*, in which the film washing is done. Since the films are first

Method III.—For adapting a milk-cooling unit, "DRD-4," to the x-ray dark room.

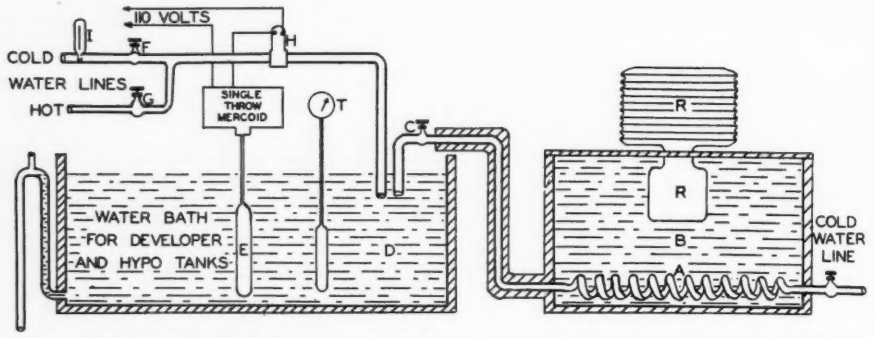

Fig. 3. System employing a milk-cooling unit with cooling coil, tap and hot water lines, and single-throw Mercoid switch with solenoid valve.

washed (between developer and hypo, and then after the hypo) in tank *A*, the pollution of the wash water is lessened by having the flow of water from tank *F* into tank *A*. The temperature of the water is regulated by means of the double throw Mercoid switch, *E*, similar to that described in Method I. An appropriate flow of tap water is admitted to the tank *F* by the manually controlled valve, *D*. For summer operation, the double throw mercoid switch is connected to solenoid valve *H* by switch *S*, as indicated. For winter operation, *S* is changed so as to connect solenoid valve *G*. When the water around the bulb drops below 65° F. the Mercoid switch actuates solenoid valve *G*, which allows hot water to flow. This brings the temperature in tank *F* to a little over 65° F., causing the Mercoid switch to open the electrical circuit and shut off the hot water. In the summer, when the temperature of the incoming tap water is above 65°, the valve *E* is closed, *C* is opened, and the switch *S* changed. The Mercoid switch then opens the solenoid valve *H*, allowing ice water to flow into tank *F*. When the temperature is a fraction of a degree below 65° the Mercoid switch closes valve *H*. A dial thermometer, *T*, is placed in the water to check the temperature at all times.

The above unit has many advantages from the standpoint of the roentgenologist, chief among which are cleanliness, silence, and the fact that all moving parts are hermetically sealed in the compressor compartment. The design is such that we were not successful in arranging the temperature control to turn the compressor on and off at the 65° to 68° temperature level, but this compressor is fitted with its own temperature (pressure) regulator which, when set at maximum temperature (warm end of range), will maintain a temperature of about 45° F. The motor of this unit is of only $^1/_3$ H. P. and when the incoming tap water registers 80° to 85° F., as in Philadelphia during the months of July and August, one is limited to a maximum possible flow of about one-fourth gal. per minute if 65° is to be maintained in the tank system.

Referring to Figure 3, water from the cold water main enters the copper coil *A* (50 feet of $^3/_4$ inch tubing). This coil is immersed in a water-filled tank, *B*, into which is immersed the cooling coil *R* of the refrigeration unit. Water in the coil *A*, after being cooled, is manually regulated by the valve *C* so that a small stream enters the large tank *D*. Valve *C* should be a good needle valve and when once adjusted need not be touched for con-

siderable periods of time. In tank *D* are placed the developer and hypo containers. The film-washing may be done here, but it is preferably done in a separate tank if a large volume of work is being handled. (If such a separate washing unit is installed, the arrangement of Figure 2 is followed, so that the fresher water is available for the final washing.) The bulb *E*, of a single throw Mercoid unit, operates the switch when the temperature of the water falls below 65°. This opens the solenoid valve *H* and allows water from the incoming tap water mains to flow into tank *D*. During the part of the year when the refrigeration equipment is in use, the temperature of the incoming tap water is above 65° F. Therefore, the valve *G* is closed and the valve *F* is opened. When the water in the tank *D* is warmed to about 66°, the Mercoid switch opens and the solenoid valve shuts off the tap water. In this way the temperature of the solutions is kept within narrow limits. In operation, it will be found that the needle valve *C* must be rather carefully adjusted. If opened too widely, especially during midsummer, the refrigeration unit will be overworked (will run constantly instead of intermittently), and the temperature of the tank system may rise above the desired level. In midsummer, this valve *C* is properly adjusted when the refrigeration unit operates intermittently "on" about two-thirds of the time. Naturally, when the temperature of the incoming tap water is less elevated, as in the spring and autumn, the refrigeration unit will be in operation for a smaller proportion of the time. As stated above, we have found it desirable to place the temperature control of the DRD-4 unit at the extreme warm end of its range (about 45° F.).

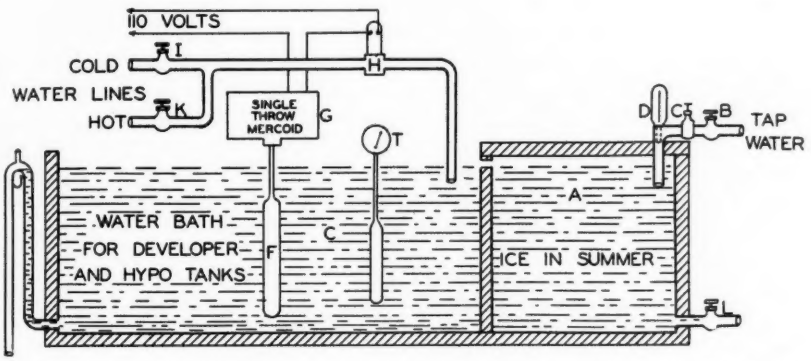

Fig. 4. Method for use where ice is used for cooling and hot water for heating, with a single-throw Mercoid switch.

If the water entering *A* is above 65° F., as in the summer, the refrigerator unit functions as described. But if it is below 65°, as in the winter, this unit may be turned off, valve *G* opened, and *F* closed. The height of the water in *D* is kept at a constant level by the pipe arrangement, as indicated.

Method IV.—Ice is used for cooling and hot water for heating, with a single throw Mercoid switch (Fig. 4).

With this method, in the summer, ice must be carried into the dark room and placed in the heat-insulated tank *A* (Fig. 4). Water passing into this tank is manually regulated by the needle valve between *B* and *D* and after being cooled by the ice, flows over into the large tank *C*. This flow is constant and is maintained as small as possible consistent with keeping the temperature of the main tank down and allowing for sufficient washing of the films. The partition between tanks *A* and *C*

should be made of a fairly good heat-insulating material. The developer and hypo tanks are placed in *C* and all of the film-washing is done here. Thus if only a very small amount of water from *A* is allowed to flow, the wash water may become too contaminated, whereas if too much water is allowed to flow, it uses up the ice too rapidly.

The constant flow of ice water from *A* is warmed to 65° by the tap water in the summer. In the winter when the incoming tap water, as indicated by *D*, is below 65°, no ice is used in *A*. In this case, valve *I* is closed and *K* opened, so that again cold water enters tank *C* from *A* and warm water from *H*. The temperature is regulated as described in the other methods, by the Mercoid switch *G* and the solenoid valve *H*. The tanks *A* and *C* are surrounded by heat-insulating material. Tank *A* may be partially emptied before being replenished with ice, by opening valve *L*. The water level in *C* is maintained by the inverted *U*-pipe, as indicated. Water is drawn off from the bottom of the tank so as to encourage better circulation and lessen contamination.

Method V.—Where ice is used outside of the dark room and hot water is available.

In this installation the set-up is just the same as that shown in Figure 3, except that the cooling in tank *B* is accomplished by means of ice instead of the refrigerator unit *R*, and tank *B* is placed at some convenient point outside of, instead of in, the dark room.

If space is available outside of the dark room and on the same level as the water bath, then the arrangement in Figure 4 may be used. Tank *A* is placed outside and connected with tank *C* through a heat-insulated pipe. This saves the copper coil shown in Figure 3.

The reader may not be familiar with the "siphon-drain type" of waste pipe connection shown by our Figure 1 (incompletely diagrammed in Figures 2, 3, and 4), and it is not essential. The simple ordinary standpipe arrangement, or the placing of the waste pipe outlet at the desired water level, would be applicable. The "siphon-drain" arrangement has the advantage of taking the waste water from the bottom of the tank (where impurities, especially heavy salts, tend to accumulate) instead of from the top. While not strictly included within the title of this paper, it is necessary to discuss certain difficulties which may be encountered in installations of the types indicated. For example, the drains in Figures 2, 3, and 4 will maintain proper levels and will avoid overflow, but will not remove floating particles or scum. To obviate this difficulty, one manufacturer has used the arrangement shown in Figure 1. With this arrangement, scum and other floating matter are removed, because surface water is removed by suction each time that the syphon operates and is broken at the water level. However, if a heat exchanger is installed, below the dark room, as shown in Figure 1, or if the waste runs into an unvented trap, air can accumulate in the pipe connecting the siphon to the heat exchanger or trap, resulting in a back-pressure which will prevent the siphon from functioning before the wash tank or water bath overflows on the floor. To prevent this, a small standpipe reaching above the tank-water le els may be inserted in the horizontal limb of the drain pipe under the dark room tanks, allowing accumulating air to escape.

PRINCIPLES INVOLVED IN THE APPLICATION OF REFRIGERATION ENGINEERING TO THE DARK ROOM

The reader may have no special interest in the vocabulary or formulæ of the refrigeration engineer. However, a few simple facts will enable the radiologist to examine critically the devices offered by the salesmen of refrigeration equipment and protect himself from an investment in inadequate or overpowered devices.

It may be stated at the outset that the horsepower required for the extraction of heat from water is much larger than is generally understood. To the uninitiated it may seem that a small "water-cooler,"

such as we sometimes place in our offices or corridors for the production of cool drinking water, might be adapted to the needs of the x-ray dark room. Such is not the case, for the simple reason that the suitable arrangement of tanks ("cascade tank" of Figure 1, for example), the pollution of the main wash tank by hypo can be kept so low that a flow of one-half gallon per minute, or, at the most, 1 gallon

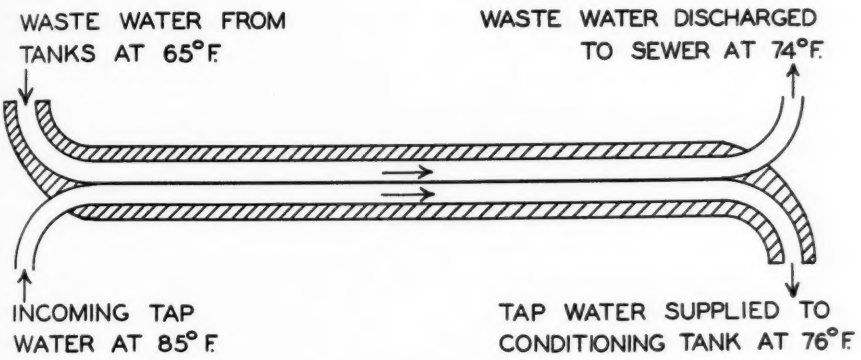
WASTE WATER FROM TANKS AT 65° F.
WASTE WATER DISCHARGED TO SEWER AT 74° F.
INCOMING TAP WATER AT 85° F.
TAP WATER SUPPLIED TO CONDITIONING TANK AT 76° F.

Fig. 5. Principle of the "heat exchanger" in which the flow of the two streams of water is in the same direction. For illustration, we have assumed that exchange of heat occurs until the two compartments are within 2° of each other. In actual practice, the completeness of the interchange will depend upon volume flow (duration of "contact" between the two streams), rate of heat conduction through the walls of the tubing, and other factors. Volume flow of waste water and incoming tap water are assumed to be equal.

flow of water required for washing x-ray films is such that a low-powered drinking water-cooler would hardly produce a measurable change of temperature.

What are the actual power requirements? The refrigeration engineer knows that when used for cooling water, with a suitable refrigerant such as methyl chloride, ethyl chloride, sulphur dioxide, or ammonia, and with an efficient compressor, a 1 horsepower motor will extract 8,000 British thermal units of heat per hour. Since 1 gallon of water weighs approximately 8 pounds, and since a B.t.u. is the amount of heat added or subtracted when the temperature of 1 pound of water is raised or lowered 1 degree Fahrenheit, it follows that the 1 H. P. motor and compressor will lower the temperature of 1,000 gallons 1 degree per hour. In other words, if the flow of water into our tanks amounted to 1,000 gallons per hour (16.7 gallons per minute), the 1 H.P. unit would lower the temperature only 1 degree F. Fortunately, such large flows are unnecessary. By a per minute, is ample. Accepting the latter figure as desirable, and disregarding, for the moment, the aid that can be realized from a "heat exchanger," we must next examine the probable temperature drop which will be required during the hottest months of the year. In our own experience (Philadelphia), incoming tap water temperatures reach 85° F. in July and August, which requires lowering the temperature 20 degrees, an extraction of 9,600 B.t.u. per hour (power requirement, at least 1.2 horsepower).[3]

The actual requirements (flow of water) are slightly greater in the system advocated for the busy dark room (Fig. 1), because approximately one-half gallon per

[3] One gallon per minute = 60 gallons per hour.
Sixty gallons weigh approximately 480 pounds.
Four hundred and eighty pounds lowered 20 degrees = 9,600 B.t.u.
Eight thousand B.t.u. per hour require 1 H.P. (minimum).
Therefore, 9,600 B.t.u. will require $\frac{9,600}{8,000} \times 1$ H.P. = 1.2 H.P.

minute is used for the flow into the water bath ("master tank") in which the developer and hypo inserts are placed. This is in addition to the one gallon per minute already appropriated for the wash tank, requiring a total of one and one-half gallons per minute, or 1.8 horsepower. It is fortunately possible to design a fairly inexpensive "heat exchanger" which materially reduces this power requirement.

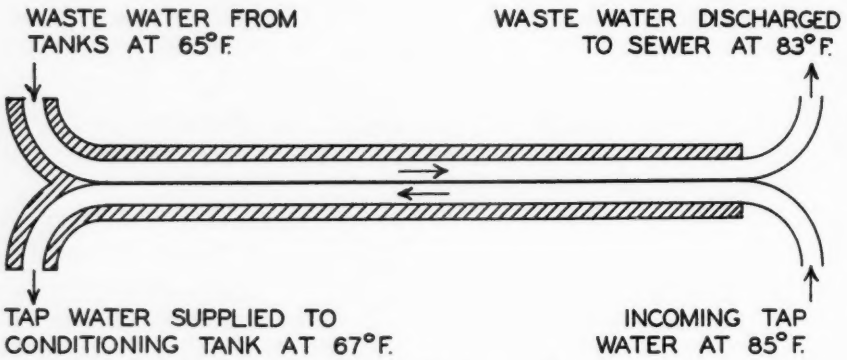
WASTE WATER FROM TANKS AT 65°F.
WASTE WATER DISCHARGED TO SEWER AT 83°F.
TAP WATER SUPPLIED TO CONDITIONING TANK AT 67°F.
INCOMING TAP WATER AT 85°F.

Fig. 6. Principle of the "heat exchanger" in which the flow of the two streams of water is in opposite directions. (Compare Fig. 5.)

HEAT EXCHANGERS

It is obvious that admixture of a gallon of water at 85° and a gallon of water at 65° will produce two gallons of water at (approximately) 75°. At first glance it might appear from this that a heat exchanger operated by waste water at 65° is operating at 100 per cent efficiency if its discharge of waste water is at 75° and its tap water stream is cooled from 85° down to 75°. This would certainly be the case in an arrangement such as that of Figure 5. However, the exchange of heat between the waste water and tap water compartments will always be incomplete. In Figure 5 we have assumed that exchange ceases at about two degrees difference (between the compartments).

However, a simple rearrangement of the apparatus, as in Figure 6, produces the possibility of a surprising increase in the desired exchange of heat. (We are indebted to Robert R. Newell, M.D., Professor of Medicine (Radiology), Stanford Medical School, for calling our attention to this principle.)

It will be noted that the heat exchanger shown in Figure 1, which we have used for several years, fulfills the requirements of Figure 6 as to direction of flow. The waste water enters the open tank (an old 20-gallon "hot water boiler" from which one end has been removed) at its bottom. In the summertime, when the action of the heat exchanger is most important, the waste water is progressively warmed as it moves upward in this tank. Convection currents are thus avoided. (If the relatively cool waste water from the tanks were brought in at the top of the open tank, convection currents would quickly destroy the desired temperature gradient.) The incoming tap water enters the copper coil at the top, and does not reach the cool end of the exchanger until it has been progressively cooled by passage through the entire length of the exchanger, thus fulfilling the requirements of Figure 6.

Unfortunately, the open tank type of heat exchanger is difficult to incorporate in the x-ray laboratory unless space is available on the floor below. Various makeshifts must be resorted to in cases in which this arrangement is impossible. For example, the waste water from the

tanks may be run into one end of an open tub on the same floor level as the dark room. From the other end of this tub, or tank, the water is discharged into the sewer. The incoming tap water from the dark room is run through a coil of copper tubing which is immersed in the tub. The direction of flow favorable for the most efficient exchange of heat is that indicated in Figure 6. The tub should be heat-insulated and long and narrow, to discourage convection currents from equalizing the temperature between the inflow and outflow ends.

In designing the heat exchanger it may be useful to know that the volume capacity of one-half inch inside diameter tubing is one gallon per 98 feet, and of five-eighths inch inside diameter tubing, one gallon per 63 feet. An adequate length of tubing should be incorporated so that the incoming tap water requires some minutes for its passage through the exchanger, otherwise sufficient time will not elapse for the desired change of temperature.

It is obvious that there are many possible designs for a heat exchanger. For example, one could be built in substantially the form of our Figure 6. Co-axial tubes at once suggest themselves. Experience indicates that such theoretically desirable arrangements are impractical because of the rapid accumulation of clogging vegetable matter in the waste pipes from film-washing tanks. (This may be due to a combination of gelatin, bacteria, and algæ; at any rate, it is quite marked.) The same objection holds for any closed tank system, in which cleansing of the waste water compartment would be difficult or impossible.

SUMMARY

1. The desirability of automatic, year-round temperature regulation in the x-ray dark room tanks is discussed.

2. Various methods of accomplishing the desired result are described.

3. The essential formulæ of the refrigeration engineer are reviewed, together with fundamental principles for the design of "heat exchangers."

THE CLINICAL AND ROENTGENOGRAPHIC INTERPRETATION OF LUMBOSACRAL ANOMALIES[1]

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THE significance of lumbosacral anomalies is closely related to certain clinical concepts which, in turn, have distinct bearing on the treatment. For this reason, these clinical concepts and treatment will be discussed before the various common anomalies are described.

Lumbosacral anomalies produce symptoms only through faulty mechanics. Faulty support or faulty relationship produces abnormal stresses or pressures. Whether an anomaly is of faulty support or of faulty relationship, its mechanical weakness can be compensated by muscles and ligaments. As long as these soft tissues are of sufficient strength and tone to meet the conditions without fatigue, there are no symptoms—the patient is compensated.

Muscles and ligaments that are thus occupied in supporting or protecting the lumbosacral area have less than normal capacity for meeting extraneous loads or stresses, as a certain portion of their total capacity is already in use. Hence these tissues are more liable to strain than the normal; that is, their capacity to meet stresses is more liable to be exceeded, in which event the patient is decompensated and must be relieved by rest in order that these injured tissues may recover and regain a state of compensation.

Decompensation occurs in several ways:

(1) There may be an excessive extraneous load or stress directly producing a strain.

(2) As one grows older, muscles lose tone and power, so that the person who is well compensated at 20 may, at 40, have his muscle power exceeded by stresses which were easily met at 20. Accordingly, decompensation is more frequent later in life.

(3) One's routine may change from a physically active to a sedentary life. The muscles which were of good power and tone rapidly become weaker and poorer in tone so that muscles which, in the period of activity, could meet severe stresses, in the sedentary period are not equal to meeting even moderate stresses, and decompensation occurs on some slight injury. Women lead a fairly active life up to the time of marriage but on the average are much more sedentary thereafter. This, I believe, is the reason that backache of lumbosacral origin is so common among women, while many laborers who do heavy work, with muscles of good tone and power, escape it.

(4) Muscles able to meet considerable stress when prepared for it may offer little resistance if caught unprepared. The person with a lumbosacral anomaly may do heavy work with no difficulty and yet develop an acute strain with some sudden twist or turn for which the protective muscles are not prepared.

(5) Muscles that are being used constantly for protection while the patient is erect may become fatigued. Fatigued muscles may ache. This is a minor form of decompensation without acute strain but with definite low-back fatigue. Some patients, not having known any other condition, may not realize that they are fatigued. Such persons are apt to lead a sedentary life merely because they do not feel equal to anything else. Often the adolescent child who is lazy, sedentary, or a book-worm has adopted that habit because of a lumbosacral anomaly which produces chronic fatigue.

Some patients present obvious examples of these mechanisms of decompensation. A man 36 years of age worked steadily as a laborer until he was laid off for three weeks. On returning to his usual work he

[1] Read before the Lake Keuka Medical Association, Lake Keuka, N. Y., July 14, 1933.

immediately suffered a lumbosacral strain. During his lay-off period, the muscles had lost tone and power so that they were no longer able to meet stresses with the same ease as previously. If he had not been laid off, or if he had resumed work gradually, he probably would not have become decompensated. Case histories of this character are frequent in these days of interrupted or part-time labor, and can probably be prevented only by examining those destined for heavy but interrupted labor and excluding from such a régime those having lumbosacral anomalies.

An All-American football player had extensive spondylolisthesis. During his athletic days his muscles and ligaments were of such power and tone that he had no trouble with his back—he was fully compensated even for the stresses of playing football. Later, he became a bond salesman. He then led a sedentary life and, of course, his muscles gradually lost power and tone. Finally a slight jolt in a taxicab produced an acute strain.

Another football player, a young man, could easily carry a hundred-pound pack all day on a hunting trip with no difficulty, but he experienced frequent lumbosacral strains if he did not avoid sudden turns and quick twists. These were apt to catch his protective muscles unprepared and so produce a strain.

Prophylaxis.—The conception of compensation and decompensation which has been stated points the way for the treatment or prophylaxis of these conditions. For mild cases it is essential to build up muscle tone and power sufficiently to meet the stresses, that is, to keep the patient compensated. This is a matter of widespread application. A majority of women and many men have backache of lumbosacral origin by the time they are 40. That the bony mechanism should be inadequate to meet the stresses of the erect posture in a majority of persons is not surprising, as our spines were unquestionably developed for the horizontal posture and have not yet become well adapted to the vertical.

The means of building up muscle tone and power are simple but the patient is not apt to expend the effort to accomplish them and will rarely acquire a clear conception of what is necessary. The patient does not always distinguish properly between work and exercise. In the use of a muscle, decomposition products accumulate; circulation removes these products. The repeated use of a muscle through a limited range of motion accumulates these products without, at the same time, aiding the circulation. This is work, and fatigue results—a condition which is to be avoided. The contraction of a muscle through its full range accumulates decomposition products, but at the same time exerts a forceful stimulus on the circulation, the complete contraction squeezing out interstitial fluid like water out of a sponge, and leaves the tissues more free of decomposition products after the contraction than before. This is exercise and, by improving the circulation, it improves the muscle tone. The circulation may be further improved by massage, steaming, and by contrast baths. Power may be improved by making the movements through the full range of motion against resistance, to be gradually increased from day to day.

Although much can be accomplished for relief or prevention of lumbosacral decompensations when all this is understood and applied by the patient, actually few will or can apply it beneficially. Usually, therefore, the patient drifts along and has a certain number of decompensations unless resort is had to surgery.

The fusion operation, to eliminate motion and provide stability, is indicated when the attacks become so frequent and so severe that it becomes worth while for the patient to give up the time necessary for the operation in order to put an end to the attacks. The stage at which this shall be done is largely a matter for the patient to decide. If it is worth while for him to give up from three to six months for hospitalization and convalescence rather than endure the attacks, he is a proper case for operation. The

younger patient with frequent attacks, rather than the older patient, should be urged to have surgical treatment, while he is in better condition for operation than he will be later on when surgery may become unavoidable.

Many of these individuals have chronic arthritis in the spine as well as a lumbosacral anomaly. Such cases are not favorable for surgery, as complete relief cannot be expected, due to the arthritis in areas which are not to be fused. The orthopedist must thoughtfully judge what portion of the symptoms is due to the anomaly, and whether elimination of that portion by surgery will be worth while for the patient.

Belts and Braces.—The patients who are not affected sufficiently to justify surgery may be treated by other means. The use of support by means of a belt, corset, brace, or plaster may be necessary to relieve an attack but must not be continued indefinitely. Disuse of the muscles causes them to become weaker so that there is more and more need for the support and finally the patient is as little able to avoid strains with the support as he was formerly without it. The acute attack is better treated, when the patient will consent to it, by rest in a bed that does not sag; that is, a bed with a board between the mattress and the springs. Such treatment eliminates the necessity for support. Manipulation sometimes relieves an acute attack.

The symptoms and signs associated with lumbosacral anomalies may be divided into two classes: (1) The general features which may be associated with any anomaly; (2) The special features associated with a particular anomaly.

The important general features are as follows: The patient has a weak back and there is a tendency to tire easily, the fatigue being felt particularly in the lower part of the back which may lead to an aching pain in the same area. Again, there may be acute pain, in intermittent attacks, usually increasing in frequency and in duration of the individual attacks. There is a history of injury associated with the onset of the attacks of pain in somewhat more than half of the cases, although the injury may be trivial. The pain, which is affected by motion, exertion, or position, is relievable by rest. It may be associated with a particular motion, may be local in the lumbosacral area, or may radiate to the buttocks, hips, thighs, calves, sciatic nerve, or coccyx. Lumbosacral anomalies are probably the commonest cause of sciatica and coccygodynia, and a common cause of hip pain.

There may be paresthesias such as numbness, tingling, or sensation of heat or cold in the areas of radiation. These sensations may be present with or without acute pain. The radiations may be bilateral or unilateral to either side, regardless of the type of lesion or side on which the anomaly is located.

There may be spasm in the lumbosacral area, the spine being held stiff, with motion limited. Tenderness may be present in the lumbosacral or sacro-iliac areas. Often there is pain on passive motion on rotation, flexion, extension, or side bending of the lumbar spine, or flexion of the hip with the knee extended.

Other symptoms or signs associated with particular anomalies will be mentioned with them.

Diagnosis rests upon:

(1) The roentgenologic demonstration of an anomaly capable of causing the symptoms present.

(2) Pain or fatigue aggravated by exertion, especially some particular motion, and relieved by prolonged rest.

(3) Absence of demonstrable cause of symptoms other than the lumbosacral anomaly. That is, gynecologic, intestinal, genito-urinary, or skeletal disease which might cause the symptoms must be carefully ruled out.

There is no positive differentiation, by physical examination, between lumbosacral anomalies and so-called sacro-iliac strain. The results of surgical treatment indicate that when there is no definite sacro-iliac abnormality visible in the roent-

Fig. 1. On the right, the lumbosacral arch articulation is internal-external; the joint space is seen clearly between the facets. On the left, the arch articulation is anteroposterior; the joint space is not visible, and the two facets almost completely overlap each other. This is severe asymmetry of the arch articulations.

Fig. 2. The laminæ of the first sacral vertebra are not united to each other. The ossification center for the spine of this vertebra has not united to the laminæ, but is united by fibrous tissue to the spine of the fifth lumbar vertebra. This has the effect of prolonging the fifth lumbar spine downward between the sacral laminæ. This is a 45° view, that is, an oblique inferior-superior anteroposterior view. It is used to show the sacro-iliac joints, the wings of the sacrum, the laminæ of the fifth lumbar vertebra, and the relation of the sacral wings to the lumbar transverse processes.

genogram, the lumbosacral area rather than the sacro-iliac joints must be suspected as the source of symptoms.

The demonstration of the presence of the lumbosacral anomaly is a roentgenographic problem requiring, in some instances, rather extensive examination. The methods of examination will be mentioned in connection with the more frequent types of anomaly.

The Normal.—To describe the normal lumbosacral area is a task I shall not attempt. It is usually accepted as being the average of a number of individuals, and the average lumbosacral area is abnormal. Our spines were developed for the four-footed position and are not yet adapted to the erect, so mechanical weakness at the lumbosacral area is usual rather than exceptional. We must consider the lumbosacral area not as normal or abnormal but as mechanically sound or mechanically unsound.

The Articular Facets.—Stability, or sound mechanics, at the lumbosacral area depends in a great degree on the lumbosacral arch articulations. The most stable condition is present when the facets are of the internal-external type, that is, when the joint is in the sagittal plane (Fig. 1). In the roentgenogram, such a joint shows clearly, as the plane of the joint corresponds with the plane of the anteroposterior view. There may be variations from this type in many ways: the facets may incline laterally; they may be rudimentary, irregular, defective, or in various planes from the sagittal to the trans-

verse. The latter type (Fig. 1) are called anteroposterior facets and are unstable in that they allow an undue amount of motion at the lumbosacral joint. Such motion may cause trouble in various ways, as we shall see later.

Probably the worst type of facets, considered mechanically, are those which are asymmetrical. There is severe asymmetry when one facet is internal-external and the other anteroposterior (Fig. 1). With such a mechanism, every motion must put undue strain on one or the other of these facets, as they do not operate in the same plane. Practically every person with a severe degree of asymmetry of these facets has symptoms referable to the lower part of the back. Such facets are particularly liable to acute strains on twisting movements and the condition is especially difficult to combat by other than surgical measures because of the difficulty of avoiding or preventing rotatory movements.

Other anomalies may be present when the facets are mechanically inferior, and, in the presence of such other anomalies, the character of the facets is an important factor in determining the presence and degree of symptoms. When any anomaly is present the facets should be examined: if they are found to be poor, the hope of maintaining compensation is much less than it would be if they were mechanically stable.

Posterior Defect.—The laminæ of the fifth lumbar or first sacral vertebra may not be united to each other. When the defect is broad, with protrusion of a sac from the spinal canal, the condition is a spina bifida. With the defect narrow and with no protruding sac, it is often referred to as spina bifida occulta, on which many ills have been unjustly blamed. Such a defect we refer to simply as a posterior defect, and we do not consider it of any importance except that it contributes a little additional weakness when other defects are present. There are, however, some variations of this defect which do achieve significance. The ossification center for the spine of the first sacral vertebra may be present as a free piece in the arch between the laminæ. This free piece may be united to the spine of the fifth lumbar by fibrous tissue (Fig. 2) or there may be bony continuity of these parts. This has the effect of prolonging the fifth lumbar spine downward between the sacral laminæ, an anomaly which may be painful if any motion of the fifth lumbar vertebra puts pressure or pull on the laminæ of the first sacral. A symptom peculiar to this condition is a sensation of pressure in the lumbar spinal column on extension or on pressure upon the fifth lumbar spine. The condition may be relieved by removing the long spine, or, if other anomalies which necessitate it are present, by fusing the fifth lumbar vertebra to the sacrum.

Transitional Vertebra.—One of the common anomalies is a transitional vertebra (Fig. 3). The transitional formation may be present on one or both sides and in any degree, from slight enlargement of the transverse process to pseudo-arthrosis or even complete fusion to the sacral wing. It is called "transitional" because it is not truly lumbar or truly sacral in type. It may be the fifth lumbar or the first sacral. To prevent decompensation, anomalies of this type require sufficient bony union or sufficient muscular fixation to prevent motion. At the false joint between the wings there are periostium and fibrous tissue, pressure upon which is painful. Motion produces such pressure, and, if the motion is sufficiently sudden, there is a contusion, with effusion or hemorrhage attempting to occupy the negligible space between the bony processes. There is then constant pressure till the swelling subsides. In this stage, any motion is a further irritant and hence a chronic, painful condition may result.

Radiation of pain in this anomaly may be bilateral or unilateral and may be to either the right or left side, regardless of which side exhibits the anomaly. This lack of relation between the laterality of the anomaly and of radiated pain may be due in many cases to variations in the

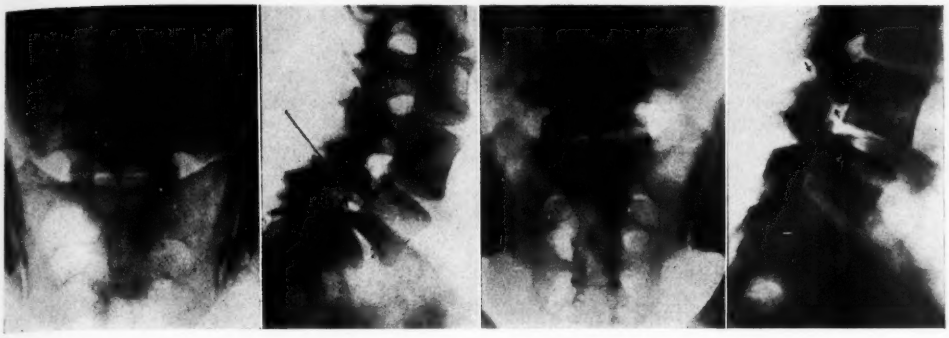

Fig. 3. Fig. 4. Fig. 5. Fig. 6.

Fig. 3. A transitional vertebra. On the right, the transverse process of the fifth lumbar vertebra is of the sacral type and forms a pseudo-arthrosis with the sacral wing. The arch articulations are poorly developed and are oblique. This is a 45° view.

Fig. 4. Spondylolisthesis. The body of the fifth lumbar vertebra is displaced forward one-quarter of an inch on the first sacral. Failure of union of the laminæ to the pedicles of the fifth lumbar vertebra is the defect (indicated by arrows) which allows the displacement.

Fig. 5. The defect which allows spondylolistheses to occur may be seen in the arch of the fourth lumbar vertebra. Where the laminæ approach the pedicles there is an irregular line where there is no bone—a complete defect across the laminæ (indicated by arrows).

Fig. 6. The same case as shown in Figure 5. The defect is also shown in this view (indicated by arrows). There is no displacement of the fourth on the fifth lumbar vertebra. This is prespondylolisthesis.

articular facets. In the presence of a transitional vertebra such as this there may be no symptoms if the arch articulations are well formed, but if they are poorly formed, symptoms are apt to be present and the side on which pain is felt is more constantly related to the type of the arch articulations than to the structure of the wings.

There may be union of the wing of the transitional vertebra to the sacral wing on one or both sides. Union on one side only cannot be relied on to prevent motion. We have a specimen exhibiting union on one side which does not prevent a definite amount of motion.

Close Spines.—The spinous processes may be in abnormally close relation, this being much more common at the fourth and fifth lumbar than at the lumbosacral joint. Such close relation may allow painful pressure or contusion, and when pain develops it is apt to be persistent. A common cause of such pain is a contusion resulting from hyperextension while diving. After such an accident pain may be present for many months, especially on hyperextension. Local tenderness at the spines involved is an important feature in this anomaly, while pain and tenderness are occasionally so chronic that one of the spines, or a part of one, has to be removed to eliminate the possibility of contact.

Spondylolisthesis.—The fifth lumbar vertebra may be displaced anteriorly on the sacrum. The amount of displacement is shown in the true lateral view of the lumbosacral joint (Fig. 4). The laminæ of the fifth lumbar vertebra are not united to the pedicles, and when the body is displaced forward the spine and laminæ are left behind. For this reason the spine of the fifth lumbar is prominent posteriorly. A depression may be felt and sometimes seen above it—a characteristic sign of spondylolisthesis. The arch of the fifth lumbar vertebra is often rudimentary. The transverse processes may completely overlap the sacral wings in the anteroposterior view, due to the anterior displacement.

How and when the displacement occurs has not been definitely determined. Of course, trauma may produce the displacement, and also there may be gradual slipping without trauma, although I have

not observed this in any case. The displacement does not have much, if any, tendency to increase spontaneously: I have not seen any increase in cases observed over a period of several years. Yet these cases have had several decompensations while under observation, which fact demonstrates that this condition is subject to the same conception of compensation and decompensation as other anomalies. Although attacks of severe pain may be due to increase of displacement, most of them are due to strains which occur because of the mechanical weakness, that is, they are due to decompensation. I will not be surprised if we eventually find that the displacement occurs in fetal life.

Routine Examination.—The basic routine examination of the lumbosacral area should consist of a true anteroposterior and true lateral view, and an anteroposterior view oblique from below upward, commonly called the 45° view (Figs. 2 and 3). Each of these films should be made in the true plane, with the patient lying in the normal relaxed posture. The hips should not be flexed nor the lumbar spine flattened, as such a position does not allow the normal mechanics of the region to be visualized. Other views which may be necessary in certain cases will be mentioned later.

The 45° view is of great value in the study of the sacro-iliac joints, the sacrum, the state of fusion of the sacral wings, the transverse processes of the fifth lumbar vertebra with their relation to the sacrum, and the condition of the arch of the fifth lumbar vertebra.

Prespondylolisthesis.—The defect which allows spondylolisthesis to occur is usually visible in the lateral view, may be seen in the anteroposterior view, but is best demonstrated in the 45° view. The defect is in the lamina just before it joins the pedicles (Fig. 5), and it may be present on one or both sides with or without displacement. When there is no displacement the condition is prespondylolisthesis (Fig. 6). Acuteness of the lumbosacral angle has nothing whatever to do with the question of whether or not prespondylolisthesis is present. The case shown exhibits no displacement of the fourth lumbar but has failure of union of the lamina to the pedicle on each side.

Whether or not there is displacement, the defect in the lamina may become united with advancing years, and many other congenital divisions show the same tendency. I have twice seen this defect unite while under observation, but do not consider this as evidence that fracture was present. Union of the defect does not prevent further attacks of decompensation. As symptoms are not present in some cases with displacement but may be present without displacement or with displacement and united defect, it is evident that symptoms are related to lack of stability rather than to the occurrence of displacement.

Errors.—Spondylolisthesis is not a particularly uncommon condition; I have several times seen three cases in a single day. It is, however, often unrecognized because of failure properly to examine the lumbosacral area roentgenographically. In fact, the errors arising from failure to make true anteroposterior, lateral, and 45° views for the routine examination of this area are many, such as failure to detect anterior or posterior displacement or an unstable lumbosacral angle, or to diagnose sacro-iliac strain because of failure to demonstrate lumbosacral anomaly. A recent article claims a relation between the occurrence of lumbosacral pain and thinness of the lumbosacral disc—there is no such relation. The disc which appears thin posteriorly (Figs. 7, 9, 10, and 12) will almost always appear normal if the patient is examined in flexion (Fig. 13); the condition is not a rupture of the disc but a phase of normal motion. The lumbosacral disc may be thin because of sacral type of development or lack of motion. (Motion during the growing period causes the disc to grow larger, while absence of motion prevents growth.) Only rarely is the disc significantly abnormal and then only in a few of the cases

Fig. 7. Fig. 8. Fig. 9. Fig. 10.

Fig. 7. Posterior displacement of the fifth lumbar on the first sacral vertebra. The fifth lumbar vertebra is also tilted posteriorly, a fact which indicates that abnormal mobility may be present, and hence the displacement may not be constant. The lumbar spine has less lordosis than usual, this being common in posterior displacement. The lumbosacral angle is acute (52°).

Fig. 8. Lumbosacral angle slightly acute; patient in a horizontal position.

Fig. 9. Same case as shown in Figure 8; patient in an upright position. Compared with the horizontal position, the pelvis has tilted forward, lordosis is increased, and the lumbosacral angle is slightly more acute—there is "sag" at the lumbosacral joint. This is a normal reaction of symptomless spines when standing.

Fig. 10. An acute lumbosacral angle (59°); patient in the horizontal position.

that have had severe injury or marked arthritis. Thin discs are as frequent in cases without symptoms as in those with symptoms. The cases in which the disc is thin posteriorly usually have excessive mobility, and lack of muscular control of this instability is the cause of decompensation, as in other conditions.

Posterior Displacement.—While it is true several authorities have stated that posterior displacement of the fifth lumbar vertebra does not occur, the proper interpretation of such statements is that the authorities did not obtain true lateral views of the lumbosacral joint in their routine examinations. As a matter of fact, posterior displacement of the fifth lumbar vertebra is one of the commonest of the significant lumbosacral anomalies and one very commonly associated with symptoms.

Figure 7 shows the fifth lumbar vertebra displaced posteriorly about one-quarter of an inch. These displacements are often variable, varying with the position of the patient or they may be present at one time but not at another. The reason for this is that they occur when there is an abnormal amount of mobility of the fifth lumbar on the first sacral vertebra. In posterior displacements the arch articulations are usually of anteroposterior type, as this is the type which allows most motion at the lumbosacral joint. This displacement may occur, however, with internal-external arch articulations and there is often slight or a questionable degree of displacement with asymmetrical arch articulations. There is usually decrease of the lumbar lordosis and sciatica is frequent.

Acuteness of the lumbosacral angle is no bar to posterior displacement (Fig. 7), as the mechanism of the displacement is as follows: On hyperextension, the lumbosacral joint being hyper-mobile, the fifth lumbar glides backward on the first sacral vertebra—an exaggeration of the normal motion. Then on flexion, instead of gliding forward, the fifth lumbar tilts forward, being caught in the position of posterior displacement. The displacement may often be reduced by reversing this process, extending the spine, and then gently flexing it with traction on the pelvis. Reducing the displacement does not cure the condition, however, as the fundamental difficulty, which is still present, is the abnormal mobility which allowed the displacement in the first place.

Unstable Lumbosacral Angle.—The lumbosacral angle may be mechanically unsound in one or both of two ways:

(1) The center of gravity of the trunk, as represented by a vertical line through the center of the third lumbar body, may pass anterior to the sacrum, sometimes as much as two inches. Insofar as this line is anterior to the sacrum, a certain portion of the weight is not sustained by bone, but by muscles and ligaments, which are, therefore, liable to strain.

(2) If the plane of the articular surface of the first sacral vertebra is too far from the horizontal, sheering stresses are set up which again make the muscles and ligaments liable to strain. When this surface is 42° from the horizontal axis of the patient these stresses are of some moment; when the angle is 47° they are a menace; when the angle is 52° or more the stresses are severe.

A method of measuring this angle is as follows: In the roentgen examination, the film is placed parallel to the patient so that the edges of the film register the vertical and horizontal positions, the angle of the sacral surface to the horizontal edge being readily determined in the true lateral view.

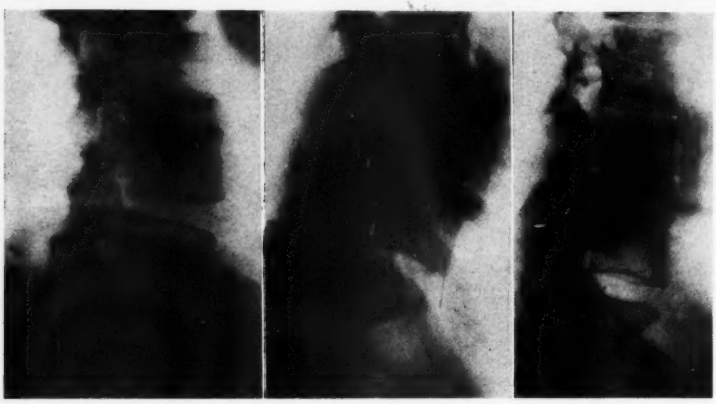

Fig. 11. Fig. 12. Fig. 13.

Fig. 11. Same case as shown in Figure 10; patient in the upright position. The lumbosacral angle is now 48°. The pelvis has been tilted posteriorly, reducing the lumbosacral angle and bringing the surface of the first sacral vertebra more directly under the line of weight thrust. This is a "protective reaction."

Fig. 12. Spine extended. The fifth lumbar vertebra is tilted posteriorly and slightly displaced in the same direction. The lumbosacral disc is thin posteriorly.

Fig. 13. Same case as shown in Figure 12; spine flexed. There has been 15° motion of the fifth lumbar on the first sacral vertebra. The spines of these vertebræ have separated five-eighths of an inch. The disc is no longer thin, posteriorly or elsewhere.

An acute lumbosacral angle is shown in Figure 7 and in Figure 10. It is obvious that the sacrum does not offer proper support to the weight thrust, and abnormal stresses on the muscles and ligaments may be present. An unstable lumbosacral angle may, of course, be present with other anomalies and add to their effect.

Protective Reaction.—The lumbosacral angle should be determined with the patient in a horizontal position, the reason being demonstrated in Figures 8 and 9. With a lumbosacral structure which is mechanically sound, the lumbosacral angle is more acute when standing than when lying, due to slight sagging forward of the pelvis on standing. If, however, there is a mechanical weakness which is producing the symptoms, the patient, on standing,

tilts the pelvis backward so as to reduce the lumbosacral angle and bring the sacrum more under the line of the weight thrust—a protective reaction as shown in Figures 10 and 11. For this reason the lumbosacral angle, with the patient standing, may appear worse in a normal subject than in one who has lumbosacral weakness. Accordingly, the angle must be measured with the patient lying in a relaxed posture. You may also deduce from this that the determination of the presence of a protective reaction, on comparing the results of an examination with the patient first in a horizontal position and then in a vertical one, serves to determine, in a questionable case, that symptoms are arising from the lumbosacral area, while absence of the protective reaction indicates that no symptoms are originating in this area at the time of the examination. In questionable cases we must, therefore, add to the routine examination a lateral view with the patient standing.

If the lying and standing views are to be compared, it is necessary that each be made in the habitual relaxed posture of the patient. The hips must not be flexed when the examination is made and each view must be a true lateral one.

Abnormal Mobility.—When the examinations already mentioned have not revealed a definite anomaly and yet the symptoms seem to be of lumbosacral origin, a more extensive examination is indicated. The anteroposterior mobility of the fifth lumbar vertebra should be determined for the reason that abnormal mobility at this joint is just as much a mechanical weakness as is a bony anomaly. The amount of mobility is determined by making true lateral views in flexion and in extension (Figs. 12 and 13). Fifteen or more degrees of anteroposterior motion, or a movement of the spines of the fifth lumbar and first sacral vertebræ, more than one-half inch relative to each other, constitutes sufficient mobility to be a cause of symptoms. Increased mobility may be sustained if the lumbosacral angle is near the horizontal, less if it is near the vertical. When symptoms are severe spasm may limit mobility, but such cases are not apt to be diagnostic problems because of protective reaction on standing being marked, and the clinical picture quite characteristic.

Fig. 14. The posture in a case of "slipping" fifth lumbar vertebra. The spine deviates to the left, displacing the trunk to that side. In this case, pain was on the right at the lumbosacral junction.

"Slipping" Spines.—One of the possible results of abnormal mobility is a clinically characteristic condition which we call a "slipping fifth lumbar vertebra." The patient has a sudden attack of acute pain which as suddenly ceases, its onset or cessation being accompanied by a sensation of something slipping in the lumbosacral area, sometimes with an audible snap. During such an attack, the patient has a characteristic posture (Fig. 14).

The fifth lumbar vertebra is tilted away from the painful side; the spine deviates in the direction of the tilt, the trunk being offset to that side, and the opposite hip is prominent. The peculiar posture is often more marked when the patient is standing than when he is recumbent. These patients may have no anomaly other than abnormal mobility. The condition may occur in patients with posterior displacement of the fifth lumbar but often there is no displacement. For these reasons the explanation of just what occurs is doubtful. It may be that there is a hernia of soft tissues into the space bounded by the sacrum, ilium, ilio-lumbar ligament, transverse process, and body of the fifth lumbar, and that the peculiar posture is an attempt to lift the transverse process away from the tissues upon which it is pressing.

The chief varieties of lumbosacral anomalies have been exhibited, and, in conclusion, may we emphasize that which must be evident, namely, that the most important factor in determining the condition and clinical significance of the lumbosacral area is thorough examination. The routine roentgenographic examination should certainly include true anteroposterior, lateral, and 45° views. If these do not make the situation clear, they should be supplemented by lateral views in flexion, extension, and standing; anteroposterior view, standing, and, sometimes, oblique views to determine the relation of the fifth lumbar to the ilium or the plane of its articular facets.

DEPTH DOSES OF ROENTGEN RADIATION, STRIKING AT ANGLES OTHER THAN 90 DEGREES, MEASURED IN A WATER PHANTOM[1]

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INTRODUCTION

THE distribution of the intensity of roentgen rays in a water phantom has been investigated by many authors, among whom are Dessauer, Glocker, Duane, Holfelder, Glasser, and Weatherwax. Together with variations in voltage, distance, filter, size of field, and position of the diaphragm, placed either near the tube or near the phantom, the isodose curves would change in a way characteristic of each particular arrangement.

Only four conditions were constant in all the measurements made heretofore: (1) The angle at which the central ray struck the surface of the water phantom always remained at 90 degrees; (2) the surface of the phantom was always level; (3) the phantom was large enough to guarantee the fullest effect of the scattering, and (4) the medium in the phantom was of an even density. In other words, the investigations have been made under truly ideal conditions. The only authors to have varied the fourth condition have been Wintz and Rump, Weatherwax and Robb, Leddy and Witting, Glasser, and the writer.

It appears evident that the isodose curves of a given radiation will adopt different shapes if one or all of the four above-mentioned factors are varied. They will, then, more closely approach conditions with which we have constantly to deal in our daily routine of radiotherapy. It is rather astonishing that this field has not been investigated to a greater degree, as it is obvious that such investigations will help to eliminate inaccuracy in dosage compilation.

In composing a treatment plan for a patient, the author has always felt that it was incorrect to apply the isodose charts commonly in use to the circumference of the body if the angle was other than 90 degrees, if the surface of the body was

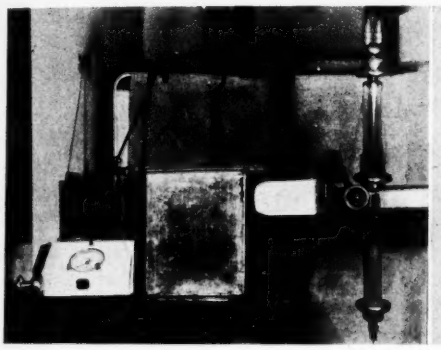


Fig. 1. Arrangement of tube, phantom, and ionization chamber. (The registering instrument to the left of the phantom was placed in the control room at the time of the experiments.)

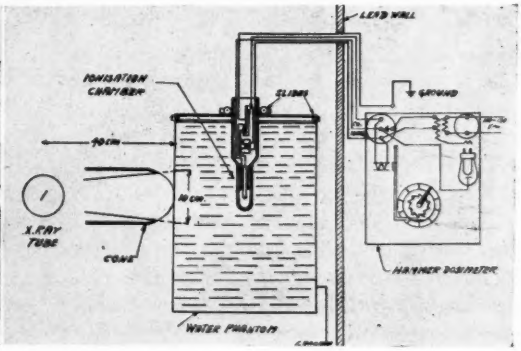


Fig. 2. Diagram of Hammer dosimeter mounted on the water phantom.

[1]Read before the American Congress of Radiology, at Chicago, Sept. 25–30, 1933.

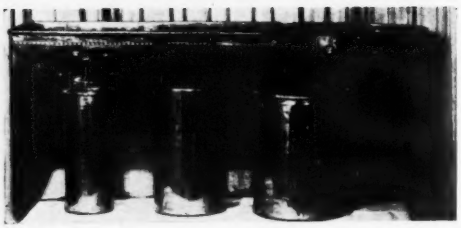


Fig. 3. The phantoms used in the experiments were made of 1 mm. aluminum.

curved, if the volume of the part radiated was small, or if the rays had to pass through media of different density, such as human tissue and gas. In such instances, the intensity in the depth must be lower than the intensities indicated by the present isodose charts.

TECHNIC

It is the scope of this paper to cover variations in the relation of central ray and body surface, even or curved, and the decrease of intensity in objects smaller in volume. All other conditions, such as voltage, distance, size of field, filter, and position of the diaphragm, remain unaltered. They are as follows: 180 K.V. constant potential, 4 ma., 0.8 mm. copper plus 1.0 mm. aluminum filter (in addition to this, 1.0 mm. aluminum comprising the wall of the tank), 40 cm. F.S.D., and a 10 × 10 cm. field with a Holfelder cone. The use of a cone gives the same effect as if a diaphragm were placed near the surface of the phantom. The measurements were taken with a Hammer dosimeter made by Mueller, of Hamburg. The tube was a water-cooled Metalix. The central ray had a horizontal direction, and entered the side of the phantom at certain angles through its wall of 1.0 mm. aluminum. By means of an arrangement of slides, the ionization chamber could be placed at any desired point within and without the beams of rays inside the phantom (Figs. 1 and 2). As the diameter of the chamber did not permit its center to be placed less than 1.3 cm. below the surface, all measurements on the surface and at 1 cm. depth were made on a paraffin phantom. Comparative measurements were made with the aluminum close to the paraffin and placed with the other filters. The difference was noted and the other measurements corrected accordingly. This arrangement did away with the building of a leak-proof sliding shutter through which the ionization chamber could be introduced and placed at liberty in any desired position. Furthermore, phantoms could be constructed in different shapes with curved walls. For this reason, five phantoms were made: one rectangular (25 × 30 × 60 cm.), one of oval shape (34 × 22 cm., corresponding to the shape of the average cross-section of the human body), and three of circular shape with radii of 10 cm., 7.5 cm., and 5 cm., respectively (Fig. 3).

MEASUREMENTS ON THE EVEN SURFACE OF THE PHANTOM, AT 90, 75, 60, 45, AND 30 DEGREES

If a treatment plan requires the application of a 10 × 10 cm. field at 40 cm. distance on an even surface at an angle of 45 degrees, it appears, at first sight, that the order could be interpreted or executed only in this way. However, on closer examination, a discrepancy in distance is evident, if the 40 cm. are measured from the focus to the middle or to the point of the field which is nearest to the tube, a difference in distance of 1.8 cm. (Figs. 4 and 5).

It is the more accurate procedure to measure to the middle of the field, for there is only a small overdose at the side nearer the tube. No point of the field receives 100 per cent, if the 40 cm. are measured to the edge of the field nearest the tube. The reason for this is that the surface intensity is considerably less toward the side than in the middle. In addition to this, all other points farther away than 40 cm. will receive a dose which is inversely proportionate to the square of the greater distance. Furthermore, one may be inclined to map out a 10 × 10 cm. field on the body surface, using protective material.

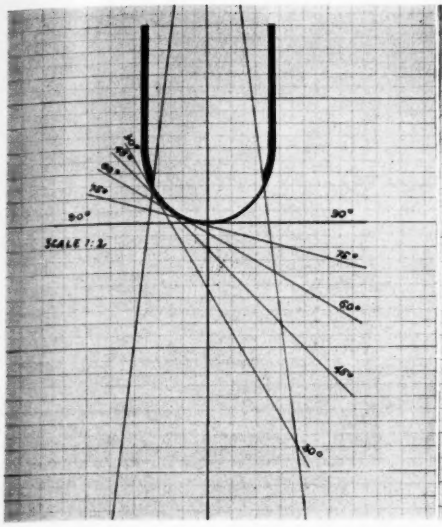


Fig. 4. Relation of curved bottom cone to the surface of the phantom at different angles. Note that the distance from focus to middle of field, and that the size of the field increases with tilting of the cone to smaller angle.

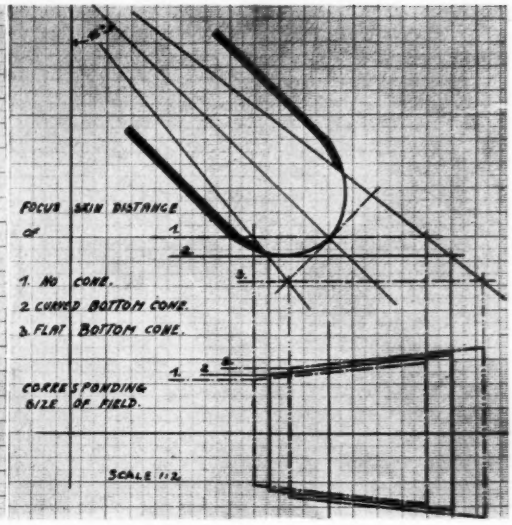


Fig. 5. With the tilting of the cone, the distance, as well as the size of field, increases accordingly, and requires additional exposure of from 5 to 20 per cent.

The area of 10 × 10 cm. should be measured at 90 degrees from the central ray rather than on the surface of the body. It projects itself on the body in the shape of a trapezium, with an area of 141 sq. cm., if measured from focus to the middle of the field. If measured from the focus to the edge of the field, it is 198 square centimeters. The latter measurement cannot be avoided if one uses a cone with a flat bottom, as the distance is fixed by the cone.

The only way to overcome these variations is to compromise on a cone with a curved bottom, such as has been devised by Holfelder, and which I have used in my experiments. The curve should be of such shape that it gives the true distance in the middle of the field. Somewhat to compensate for the decrease in intensity toward the side, the F.S.D. is less than 40 cm. at the edges of the cone.

The isodose curves obtained at a 90-degree angle do not in any way deviate from those obtained by Holfelder, Glasser, Weatherwax, *et al.* With the decrease of the angle between central ray and surface a greater distortion of the usually pear-shaped curves toward the far side of the field can be noticed in the depth (Figs. 6 to 10). At first sight, one might expect the penetration to be better at the near side from the axis of the beam, but as the intensity of the rays entering at the far side is reduced only by the distance, this more than compensates in depth value for that which has been lost through penetration of water and additional scattered radiation on the other side. This is most evident on the 45-degree chart. The 30-degree chart shows such an extreme distortion and such a poor depth dose that we may arrive at the conclusion that it is impractical to apply a field at such an angle on a rigid surface, where there is no possibility of improving the intensity and distortion by the use of compression.

It is well known that the intensity of radiation on a given field is highest at the middle, and decreases gradually toward the sides of the field. If, therefore, the treatment is given at an angle, the time of exposure must be increased to compensate for this loss of intensity, as well as for

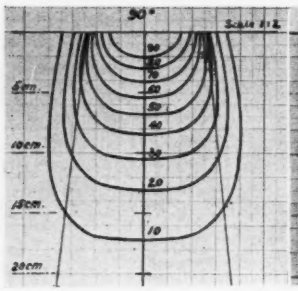


Fig. 6.

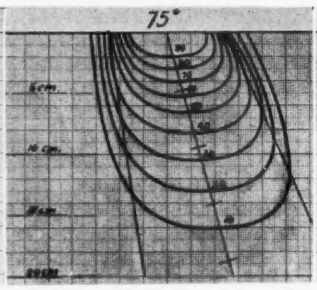


Fig. 7.

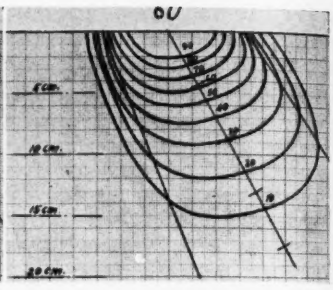
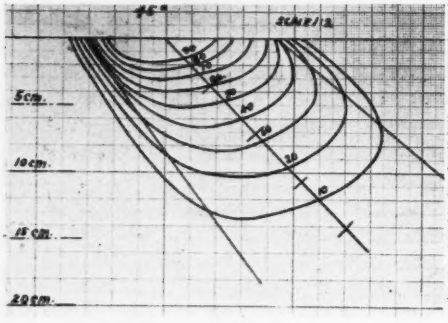


Fig. 8.



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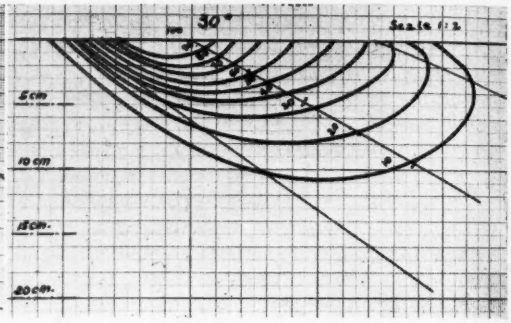

Fig. 10.

Figs. 6, 7, 8, 9, and 10. With the increase in the tilting, the isodose curves suffer a distortion, which at 30 degrees is so great that the use of such a field becomes impracticable, as the actual percentual depth dose is very small.

the loss sustained by the increased distance. At 60 degrees, 5 per cent must be added to the ordinary time; at 45 degrees 10 per cent, using a rounded cone. If a flat-bottomed cone is used, these figures must be doubled. It is obvious that they are still higher when a cone of larger size, such as a 20 × 20 cm., is used.

It need not be mentioned that all these figures apply proportionately to other dimensions of distance and size of field. If, however, a field smaller than 10 × 10 cm. is given, 10 per cent must be added for the angle as well as another 10 per cent for the smaller field.

DEPTH DOSES ON CURVED SURFACES

The oval water phantom measures 22 × 34 cm. in diameter and corresponds to the average cross-section of the human body. The isodoses in the field given at 90 degrees over the middle on the flatter side are identical with those taken on a phantom with an even surface (Fig. 11). Perhaps a more marked decrease in intensity toward the sides may be noticed, but the intensity in the depth is the same. If we apply a field to the side of the oval tank, where the surface is much more curved, and where there is not so much volume to the sides of the beam of radiation, the shape of the curves will adapt itself accordingly by becoming more slender (Fig. 12). So long as there is enough volume left beyond the limits of the beam to extract the secondary radiation scattered, which, in turn, helps to build up the intensity in the depth, we shall not observe any decrease in the intensity in the depth. This, however, will take place as soon as the oval changes to a flatter shape.

On the field at 45 degrees, directed to-

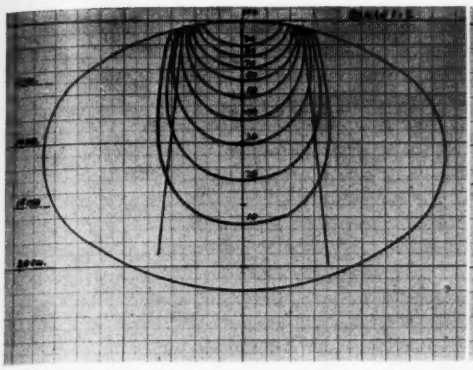

Fig. 11.

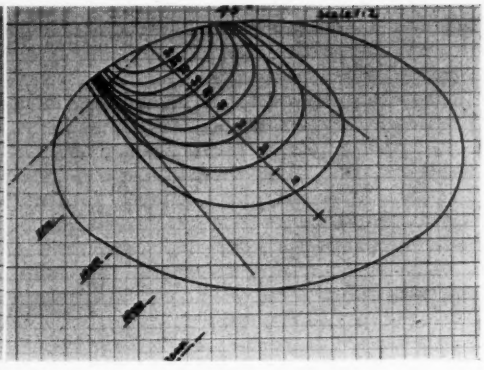

Fig. 12.

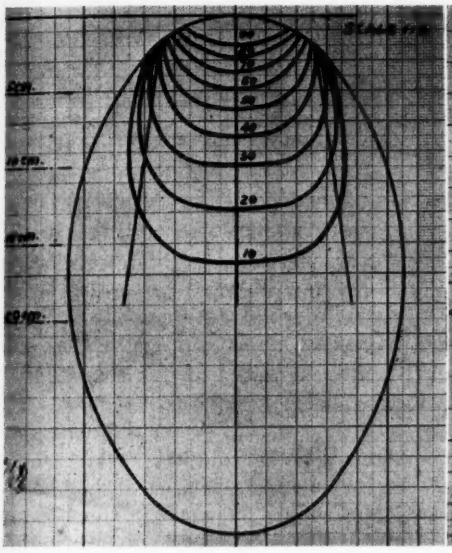

Fig. 13.

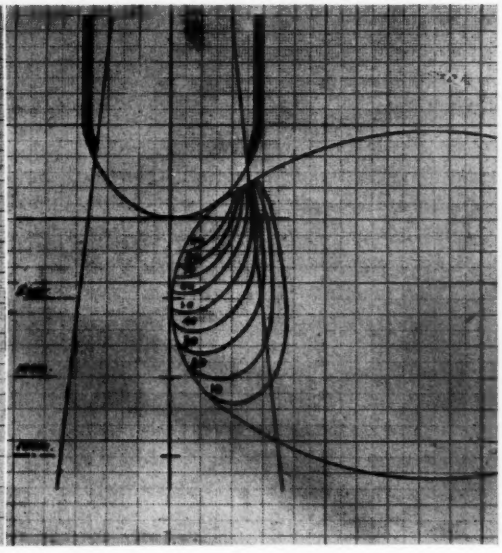

Fig. 14.

Figs. 11, 12, and 13. The oval phantom corresponds to the average cross-section of the human body. On the flat side of the oval, the isodose curves show no difference from those in a phantom with level surface. On the pointed side they are somewhat more slender. At an angle of 45 degrees the curved surface of the oval is of distinct advantage to the shape of the curves.

Fig. 14. If the rays strike the body tangentially, covering a field 5 × 10 cm., the decrease in intensity is remarkably rapid. The difference with the charts heretofore in use is striking.

ward the middle of the oval tank, we find less distortion of the isodoses than on a similar field applied on an even surface (Fig. 13). Apparently it benefits by the curve of the tank, which changes the true angle between central ray and surface to that of an angle wider than 45 degrees.

The loss in effect obtained from the additional back-scattering outside the beam can well be demonstrated on a tangential field (Fig. 14). For better demonstration purposes, a beam was allowed to enter an area which, if it were on an even surface, would have a diameter of only 5 × 10 cen-

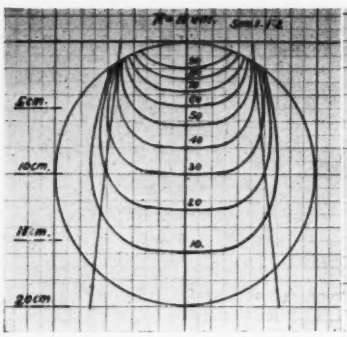

Fig. 15.

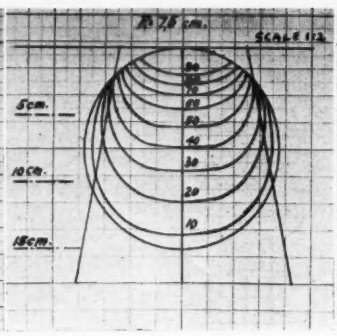

Fig. 16.

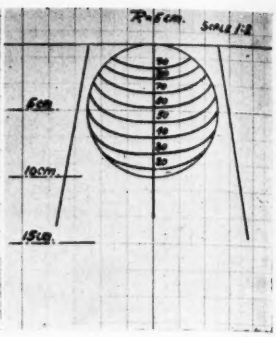

Fig. 17.

Figs. 15, 16, and 17. The proportion between size of field and diameter of radius of the phantom is of great importance. A depth intensity similar to that in a large phantom can be expected in a cylindrical body only if its radius is at least equal in length of the corresponding side of the applied field. Otherwise the intensity must be corrected to that of a field whose sides are equal to the radius of the phantom.

timeters. For this reason one could expect only a distribution of intensity which would correspond to such a field. In practice, such a field is often given with a 10 × 10 cm. cone, and an intensity taken for granted, which corresponds to one of a 10 × 10 cm. field, in place of a 5 × 10 cm. field. The error is obvious. In reality, the ionization chamber measures values which are still lower. Even with the advantage obtained by the use of a curved bottom cone, the penetration is so little that, at 10 cm., only 20 per cent of the superficial dose can be found.

Such a tangential field is used quite frequently, as, for instance, in the treatment of a breast, a shoulder, a head, or a tumor which protrudes from the surface of the body.

The high loss in intensity produced by the smaller volume radiated requires the use of isodose charts which correspond to the true condition. The application, heretofore customary, of the isodose charts obtained at an angle of 90 degrees to the surface of a water phantom of large dimensions obviously leads to a great error in the calculation of the dose.

DEPTH DOSES IN CYLINDRICAL PHANTOMS OF DIFFERENT SIZES

This loss in intensity, when a tangential field penetrates through a comparatively small volume, suggested the investigation of the distribution of the rays in phantoms of more regular shape. For this purpose, I selected three cylinders made of the same material as the other phantoms used in my experiments. They had radii of 10, 7.5, and 5 cm., respectively, and were 30 cm. high. In the phantom with the 10 cm. radius, the application of a 10 × 10 cm. field produced no appreciably different distribution of intensity in the depth, if compared with a similar field on an even surface (Fig. 15). On the 7.5 cm. phantom, in which the volume of water outside of the direct radiation is less than half of the radius of the phantom in thickness, on each side, the depth dose beyond the middle diminishes rapidly (Fig. 16). The 20 per cent curve moves closer to the 30 per cent curve, and the course of the 10 per cent curve is governed by the 20 per cent curve and the outer circumference of the phantom. Only 6 per cent leaves the cylinder.

More striking still is the difference in distribution in the cylinder of 5 cm. radius. Here the beam of the 10 × 10 cm. field covers the entire circumference of the phantom. The 20 per cent line lies close to the averted surface. Only 13 per cent leaves the tank (Fig. 17).

These experiments lead us to the conclusion that the correct proportion be-

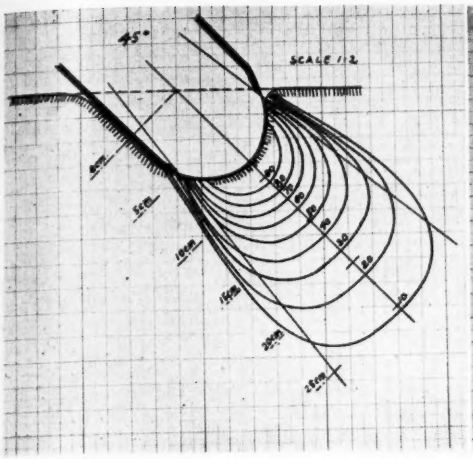

Fig. 18.

Fig. 18. The use of compression will not only bring the lesion closer to the surface, but will also do away with the distortion of the isodose curves, if the treatment is given at an angle.

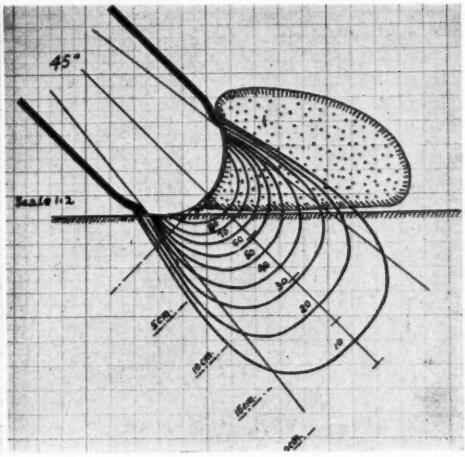

Fig. 19.

Fig. 19. If compression cannot be used, one might fill up the angle between cone and surface with scatter-producing material, such as rice. This is of no value (compare with Fig. 9).

tween the size of the field and the radius of the phantom is of great importance in regard to the expected depth intensity. The intensity in the depth is composed of the direct radiation as well as the secondary rays within and from without the direct beam. If there is little or no tissue left outside of the direct beam of rays, there will be no additional radiation from without. Therefore, a depth intensity similar to that in a large phantom can be expected in a cylindrical body, only if its radius is at least equal in length to the length of the corresponding side of the applied field, providing the central ray passes through the center of the phantom. Should the radius be smaller, the intensity of the field must be corrected, as if it were that of a field the sides of which are of the same length as the radius of the part to be rayed.

These conditions must be taken into consideration when radiating an arm, leg, or the neck of a patient. The use of the ordinary charts does not, by far, demonstrate the real conditions, and leads to a considerable underdose, which may account for many a failure in the treatment of bone malignancy.

From the amount measured on all the phantoms of different sizes emerging from the other side of the phantom it may be concluded that it is so small (slightly more than 10 per cent on the phantom with the 5 cm. radius) that it may practically be neglected on bodies with a diameter larger than 10 cm. even when computing the total dose of several fields crossing each other in the middle.

THE ADVANTAGE OF COMPRESSION AND ADDITIONAL SCATTER-PRODUCING MATERIAL

There has not been, by far, enough emphasis placed upon the advantage of the use of compression in radiotherapy. By exerting pressure with the cone on the surface of the body whenever possible, the seat of the disease can be brought nearer to the surface, and the intensity within the tumor can be increased to an astonishing degree. The surface radiated is adjusted to the cone, and an angle of 75, or even 60 or 45 degrees, can almost entirely be eliminated. Thus the intensity within the depth retains the shape of the curves from a field applied at 90 degrees (Fig. 18).

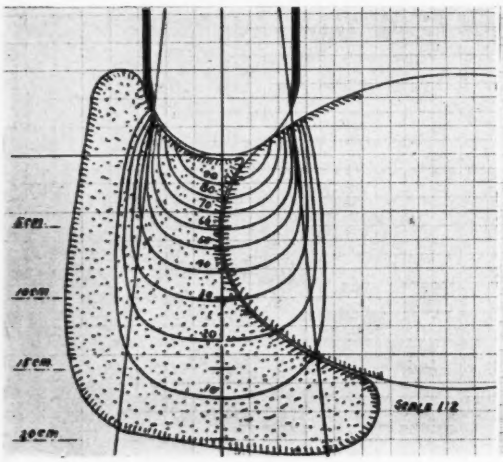

Fig. 20.

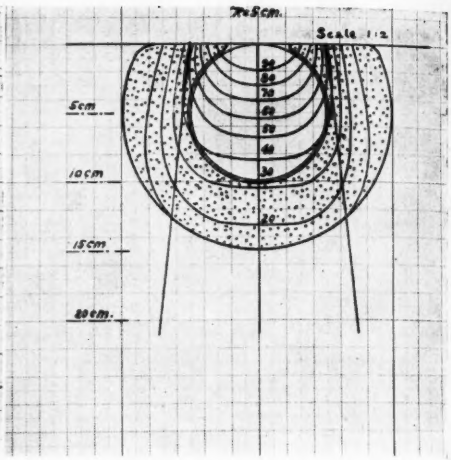

Fig. 21.

Figs. 20 and 21. Building up with scatter-producing material when giving a tangential field, or radiating an arm or leg, will produce a much greater depth intensity, and will enable us to apply the customary isodose charts.

In cases in which it is not possible to adjust the surface by compression, as, for instance, on the thorax or head, one might be inclined to expect an improvement in intensity by building up the angle between surface and cone with material producing scattered radiation, such as bags containing rice, talcum, or bolus alba and rice (Fig. 19). True, we would obtain an intensity without distortion, but we would do exactly the opposite to that of compression.

The building-up material may, however, be used to great advantage when the body to be rayed is of small volume, such as an extremity, or when a tangential field is to be given. There the scattered radiation from the material will bring the depth dose up to standard, whereas it would have been far less if the extremity were rayed alone. A tangential field on a breast, when covered with sufficient material, will now produce an intensity similar to one in a large water phantom at 90 degrees under the same conditions (Fig. 20). If a leg or an arm is embedded in a large enough layer of rice bags, the use of the ordinary intensity charts will show true figures of intensity in the depth. However, the entire diameter of leg, plus rice bags, must be twice the corresponding length of the field (Fig. 21). If rice bags, sufficiently large, are built up around the leg, the size of the field can be enlarged, and by this procedure, a better depth penetration is obtained without exposing a greater area of the leg to the rays, and without changing any other physical conditions of the treatment.

Scatter-producing material was suggested more than ten years ago by Jüngling to even up the surface of the body to be rayed, and to produce a more homogeneous distribution of the intensity. However, Jüngling expects the same intensities in a rectangular box, the sides of which are 10 cm. wide, and which contains an arm or leg to be treated, surrounded by talcum or radioplastin, as the intensities obtained in a large water phantom from a 10 × 10 cm. field. In a similar manner, he applies the same isodose chart obtained from a water phantom on cylindrical objects having a radius of from 6 to 2 centimeters.

The advantage of using the material in the manner described above becomes more apparent if a breast, arm, or leg is radiated

from two or more directions. By applying the proper isodose charts on a cross-section map, one is immediately convinced that the distribution of intensity from the fields is far more homogeneous with rice bags than without their use.

The author realizes that his investigations are far from covering the entire field of possible variations; however, this paper is intended to be of stimulus for further research in this line. The more accurate the radiotherapist, in the administration of his treatments, the more can he expect better results and less failures. In this paper attention is drawn to several factors in which inaccuracies have occurred while composing a treatment plan and computing the total dose in the tumor area. Each in itself may appear as only a negligible error, but an accumulation of these and similar errors will unavoidably lead to an irreparable mistake, which may mean death to the patient.

CONCLUSIONS

1. To apply the present isodose charts, of a beam striking the surface at 90 degrees on fields to be given at smaller angles, is inaccurate, as it does not correspond to true conditions.

2. With the increase of tilting of the beam to a smaller angle, the isodose curves become more distorted and the percentual depth dose becomes less.

3. It is not economical to apply a field at an angle smaller than 45 degrees.

4. The cone with a flat bottom should be discarded, and one with a bottom curved at the edges should be substituted. This cone will compromise with the errors originating from the difference in distance from the focus to the middle and to the edges of the field, if treatments are given at an angle.

5. In these cases, the surface dose should be increased from 5 to 10 per cent to make up for the additional distance, when using a cone with curved bottom. When using a cone with a flat bottom, these figures should be doubled.

6. The use of compression should be encouraged, as it not only brings the tumor nearer to the surface, but it also will overcome the distortion of radiation in the depth if the field is given at an angle.

7. When radiating a cylindrical body, the isodose curves are identical with those obtained in a large phantom, if the radius of the cylinder is at least equal to the corresponding side of the applied field, providing the central ray passes through the center of the phantom.

8. The custom of filling up the angle between cone and body surface with secondary ray-producing material should be abandoned, as it results in a smaller depth dose at the seat of the lesion.

9. The use of such material, however, is of great advantage when a part of the body of small diameter is to be radiated, or a field is given tangentially, as the depth intensity is materially increased, and the distribution is far more homogeneous when a cross-firing method is used.

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COMPOSITE X-RAY FILTERS[1]

By A. MUTSCHELLER, PH.D., *New York City*

IN the past, the problem of filtering x-rays for therapeutic purposes has been dealt with rather empirically; copper has been selected as the standard filter mostly for the reason that it is easily obtained in pure form. The semilogarithmic absorption curve indicates the minimum filter thickness above which the use of heavier filters does not result in appreciably larger depth doses. But, in spite of this fact, various attempts have been made to secure better results with heavier filter thicknesses than these minima, as, for instance, with 2, 3, or 4 mm. Cu or 0.5 mm. Ag.

Many clinicians hope to find a selective action of heavily filtered rays but, unfortunately, the deciding experimental evidence consists in clinical results and, therefore, the answer is not decisive. It appears, however, that several clinicians have found that, for instance, 30 ma. filtered through 2.5 mm. Cu and 4 ma. filtered through 0.5 mm. Cu, resulting in approximately the same intensities, produced identical results. This conclusion is entirely in accord with what is to be expected from physical and theoretical considerations, and it is desirable that clinicians convince themselves definitely on that point.

Another direction in which clinical improvements of results are sought is in the use of potentials up to several million volts. From the physical point of view, unless a selective or a specific action of very short wave length rays can be demonstrated, the only advantage that can be expected is a smaller ratio of surface to depth dose, *i.e.*, larger depth doses. But in the extreme case, the largest increase in depth dose obtainable appears to be about 20 per cent (5). However, such radiations penetrate not only the superposed healthy tissue layers, but also those located beyond on the far side of the tumor. Thus, the intensity and the volume of irradiated healthy tissues in relation to the dose absorbed in the tumor to be irradiated will be considerably larger, and hence the extent of injury to the patient becomes greater in proportion to an expected injury to the malignant tumor. Therefore, if a similar increase of depth dose could be attained by other means, while using radiations generated by moderate voltages, there would be decided advantages, both economic and in possible results, over and above the possibilities from irradiation with extremely high voltages.

One way, however, in which depth doses can be materially increased is by the use of greater distance; another way is through the use of more carefully compounded and adjusted filters. By the two means there seems to be a possibility of approaching the extent of depth dose increase obtainable with, for instance, two million volts.

A. THEORETICAL PART

Absorption curves of x-ray beams comprising the characteristic and the continuous spectrum of tungsten, plotted on semilogarithmic paper, first show a strong bend which gradually becomes less as the absorber thickness is increased. This indicates that the absorption coefficient, which is represented by the slope of the curve, is first very large and then gradually becomes smaller, finally approaching a constant or nearly constant value. This holds for all voltages until a minimum corresponding to 8.86 K.V. is reached. An absorption curve in tin is similar, but for the same voltage it slopes down more rapidly and the curve continues regularly down to the 29.1 K.V.

[1] Read before the American Congress of Radiology, at Chicago, Sept. 25–30, 1933.

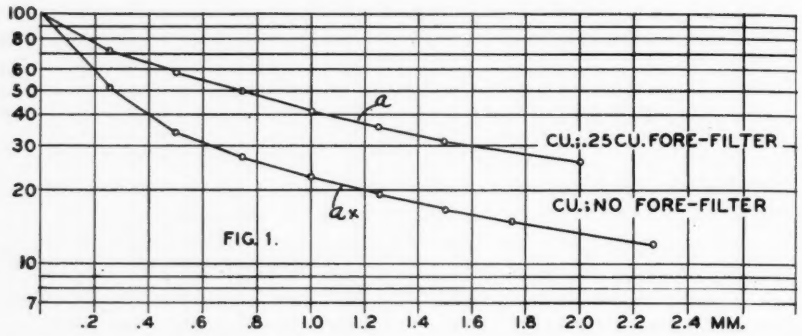


FIG. 1.

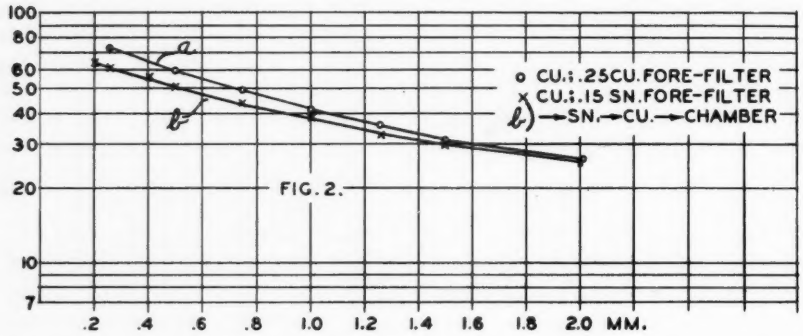


FIG. 2.

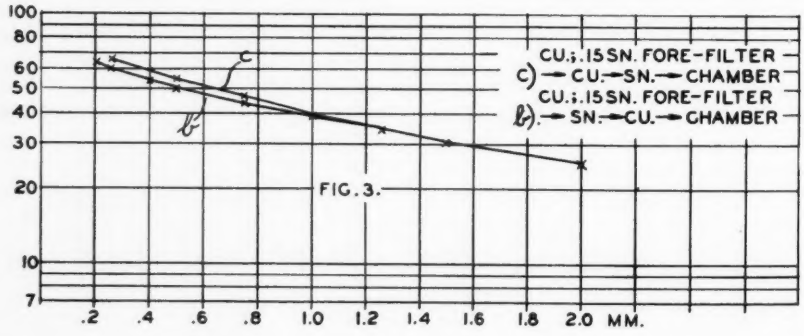


FIG. 3.

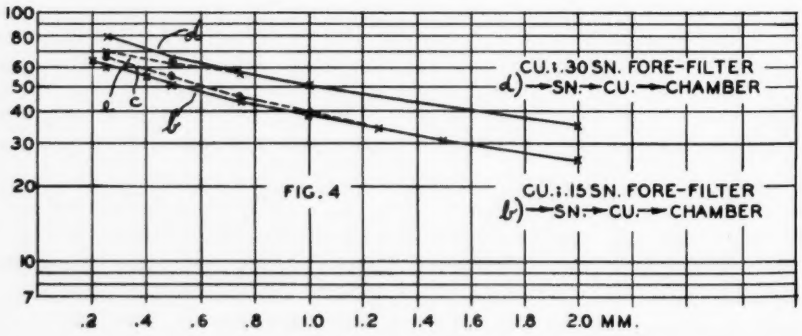


FIG. 4

radiation. It is equivalent to say that below 8.86 K.V., copper is quite transparent to x-rays, and that below 29.1 K.V., tin shows a selective transparency zone. If tin is used as a filter for a highly penetrating radiation, it effects excellent filtration and has a better homogenizing effect than copper, except that radiations below 29.1 K.V. would come through very strongly. In quite a similar fashion, if copper is used as an additional filter, it absorbs radiations effectively down to a wave length corresponding to 8.86 K.V., but from then on the softer radiations are transmitted rather freely. Therefore, it appears that the soft radiation which normally comes through tin should be effectively absorbed in copper if it is used as an additional filter, and that perhaps aluminum, if used as a third filter, would stop almost completely the 8.86 K.V. radiation coming through the copper (1). In other words, it would seem that a combination of several metals in proper arrangement would result in a more effective filter for the homogenization of the x-ray beam than would one or the other alone.

From the theoretical point of view, it might appear to be desirable to use filters of an even higher atomic number, *i.e.*, between the numbers 50 and 70, but unfortunately, the elements of this group are so rare and costly that they cannot be considered as available for this purpose. Otherwise the elements in the group from 65 to 71 might be preferable to tin.

However, for radiations produced by voltages above 200 K.V., it appears that the heavier atomic metals, molybdenum, tantalum, or tungsten, backed by tin, copper, and aluminum, might be particularly effective in bringing about homogenization of the beam with almost entire absorption of the first order characteristic K lines, and all longer wave lengths. In that case, only the short wave length portion of the continuous spectrum would be retained for application to the patient (2).

B. EXPERIMENTAL PART

Intensity measurements show that 0.13 mm. Sn transmits approximately the same radiation intensity as does 0.25 mm. Cu (3). In order to arrive at a compound filter with a total absorption value not greater than that of 0.5 mm. Cu, attempts were made to determine:

(*a*) the utility of Sn as a filter with the addition of Cu and Al;

(*b*) the correct thickness of Sn and Cu to be optimally adequate, and

(*c*) the correct thickness of aluminum. Absorption curves, spectra, and depth dose measurements were used as criteria to obtain answers to these questions.

1. Absorption Curves.—The radiation employed throughout was from a Quadrocondex uniform voltage apparatus with a ring focus pyrex wall therapy tube operated at 180 K.V. (determined from the shortest wave length). The radiation intensities were measured with a thimble type ionization chamber connected to a Wulf electroscope which was calibrated against a standard ionization chamber.

Figure 1 shows two absorption curves measured through increasing thicknesses of copper. The lower curve (*a*) represents the percentage decrease in various thicknesses of copper, taking the non-filtered radiation from the tube as 100. In the upper curve (*b*) the radiation transmitted through 0.25 mm. Cu as a fore filter was taken as 100. The bend in the upper curve is such that, ordinarily, it would seem that a filter of between 0.5 and 0.75 mm. Cu would be necessary to make the radiation sufficiently homogeneous (indicated by the approached straightness of the curve) to give adequate depth doses.

Figure 2 gives the same curve (*a*) as that in Figure 1, made with 0.5 mm. Cu as a fore filter. The lower curve (*b*) is an absorption curve in Cu with 0.13 mm. Sn (tin) as a fore filter. (The 0.13 mm. Sn transmits approximately the same total radiation intensity as does the 0.25 mm. Cu.) The latter curve (*b*), by its lesser slope or inclination, indicates that the

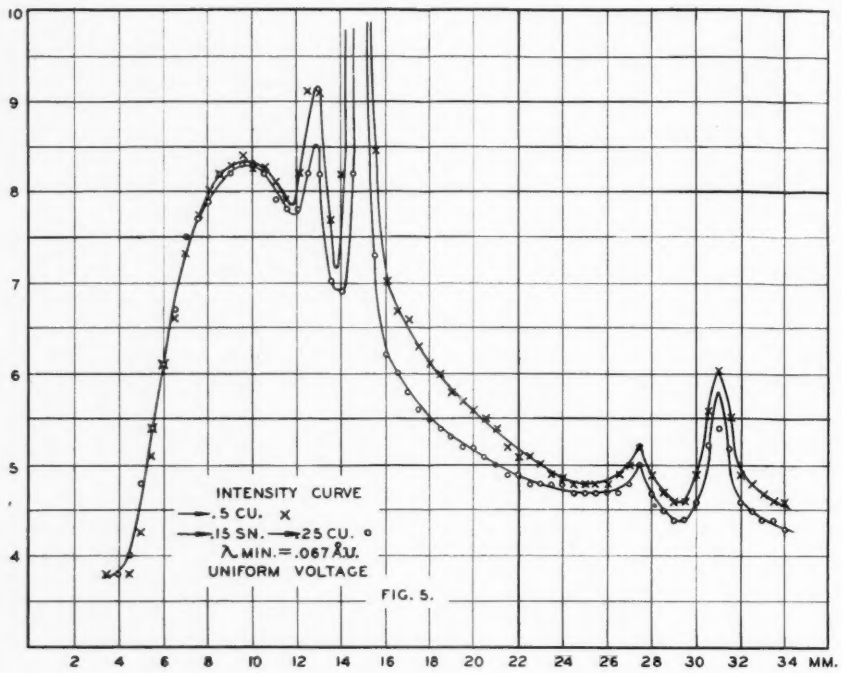
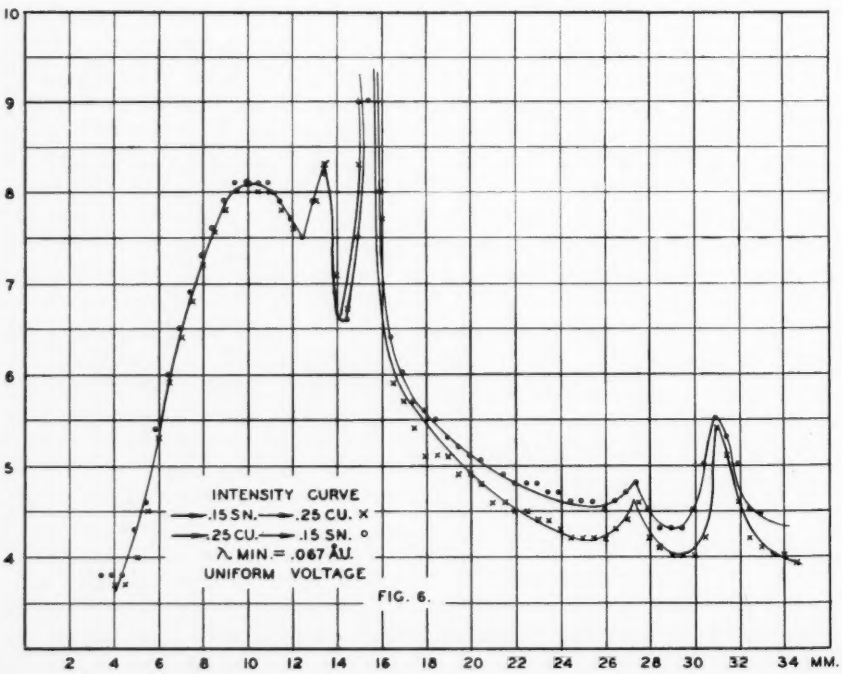

10
9
8
7
6
5
4
INTENSITY CURVE
.5 CU. x
.15 SN. .25 CU. o
λ MIN. = .067 ÅU.
UNIFORM VOLTAGE
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 MM.

FIG. 5.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INTENSITY CURVE
.15 SN. .25 CU. x
.25 CU. .15 SN. o
λ MIN. = .067 ÅU.
UNIFORM VOLTAGE
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 MM.

FIG. 6.

radiation is slightly more homogenized than that filtered through Cu, and also that, for radiation of this general type, while passing the same intensity, Sn appears to be a better filter than Cu, since it removes a larger portion of soft rays while allowing a proportionally greater portion of penetrating rays to pass through.

Figure 3 shows absorption curves of the same radiation in which the filters were interchanged with respect to the direction in which the rays traveled. In the upper curve, however, the rays first pass through the Cu, then through the Sn, and finally reach the chamber. In curve (*b*) the order of the metals was reversed. The difference in the slope indicates that when the Sn filter is nearer to the ionization chamber, there is more soft radiation contained in the beam than when the Sn filter is nearer to the tube and the Cu filter nearer to the ionization chamber. Therefore, if the filter is placed in the wrong direction, the advantages from it appear to be lost.

In order to determine whether a filter of 0.13 mm. Sn is of sufficient thickness to accomplish the desired result, the curves in Figure 4 were made. Curve (*d*) was made with 0.3 mm. Sn as a fore filter, and curve (*b*) with 0.13 mm. Sn as a fore filter. The two curves are practically parallel and are displaced only in the up-and-down direction, indicating that the general character of the radiation, or its penetrative power, has not been materially changed by the heavier Sn filter, but only that the total intensity has been decreased by the greater Sn thickness.

2. Spectra.—The differences in the radiation quality, due to various filters and as indicated by the absorption curves in Figures 1, 2, 3, and 4, are more distinctly demonstrated in the spectrograms shown in Figures 5, 6, and 7. The two spectra, which are photometered (4) in each case, were exposed side by side upon one film and identical exposure times were used, except in Figure 7, in which case, for the purpose of obtaining equal intensities, the necessary increase of exposure time for the 0.3 mm. Sn fore filter was calculated from the absorption curve.

In Figure 5, the beneficial effect of Sn as a fore filter is distinctly shown in the decreased intensity between the first and second order K lines. It is distinctly noticeable that, on the short wave length side of the first order K lines the intensities are practically identical, and this specifically greater absorption of the wave lengths between the first and second order K lines is of course due to the approach of the specific absorption band in Sn corresponding to 21.1 K.V., in which range the absorption coefficients are particularly large. The distinctly greater filtering value of the Sn filter for wave lengths longer than the first order K lines is, therefore, quite distinct. In Figure 6, the effect of reversing the direction of the radiation through the composite Sn and Cu filter is shown in that the first order K lines and all shorter wave lengths come through at identical intensities. Also, in the vicinity of the first order K lines, the intensities are practically identical. Only around the second order K lines is there a noticeable difference, indicating that the soft rays (8.86 K.V.) from the Sn have reached the spectrograph and are represented in an increased intensity in this long wave length region. Therefore, in the reversed order of the atomic numbers, a composite filter would produce a disadvantageous radiation which would tend to expose the skin to a radiation of rather low penetration, especially if the filter is near the patient.

In Figure 7, the difference between the selected thickness of Sn and a double thickness of the same metal is shown. The slightly increased absorption of the longer wave lengths near the first order K lines is probably just about balanced by the slightly lesser absorption near the second order K lines, and the point in between the K lines probably represents a transition point caused not by the critical absorption band, but rather by the equal absorptive power resulting from a balance between the rate of change of the absorp-

tion coefficient in Cu and in tin. But on the whole, the balancing effects of the absorption distances near the first and second order K lines are in accord with the characteristics shown in the absorption curve in Figure 4. The result, therefrom, is that a filter heavier than an Sn component of 0.13 mm. does not produce any measurable advantage.

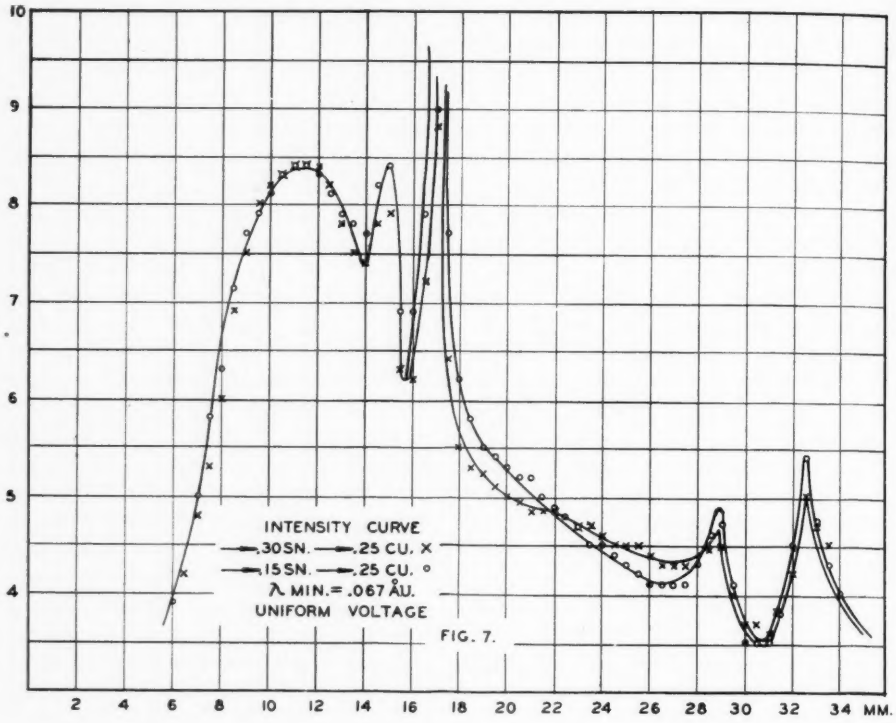

FIG. 7.

3. Depth Dose Measurements.—Probably the most important practical results are represented in Figure 8, showing the ratio between surface and depth doses. The measurements were made in water, the surface of which was 50 cm. from the target and the ionization chamber was, for surface dose measurements, one-half submersed in water. For depth dose measurements it was lowered to a distance of 60 cm. from the target without changing any other conditions.

Curve (*c*) shows the depth dose ratio obtained with various filter thicknesses of Cu, from 0.25 to 2.0 mm. thick. The straightening-out characteristic of the curve is entirely in accord with the absorption curves, and indicates that with Cu a depth dose better than about 42 per cent is not practically obtainable, even with a Cu filter of 2 mm. or more. With the usually employed 0.5 mm. Cu, a depth dose ratio of 40.4 is obtained. In curve (*a*) are given the depth dose measurements with 0.25 Cu + 0.5 Al and increasing thicknesses of Sn (the Sn being nearest to the tube). The slowly increasing depth doses indicated by this curve prove that it is not economically worth while to go beyond 0.13 mm. Sn in addition to the above-mentioned metals, and that then a depth dose of 43.2 per cent is obtained. This radiation, which is of approximately the same intensity as that coming through 0.5 mm. Cu, therefore, gives a depth dose about 8 per cent larger than 0.5 mm. Cu, or about 4 per cent larger than the best

depth doses obtainable with Cu up to 2 mm. of thickness.

Curve (*b*) is obtained by using this composite filter in the reverse direction, *i.e.*, the rays passing through Cu, then through Sn, and finally through Al. The very low depth doses shown indicate the importance of always using the metals of composite filters in the order of their atomic numbers, the metal of greatest atomic number being nearest to the tube.

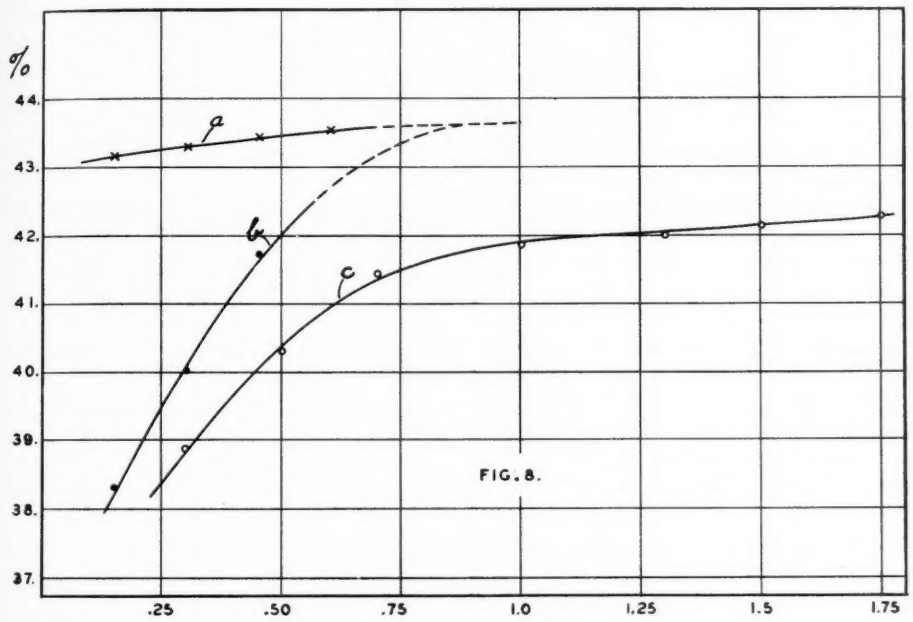

FIG. 8.

C. DISCUSSION

Striving for the best possible filter economy is justified because of the considerable saving in the cost of producing therapy radiation doses without any disadvantageous effects. It is further justified by the fact that with a given radiation and improved filtering, a larger dose can be given to a deep-seated mass than is possible with less adequate filtration. The gain from improvement in filtering methods is, therefore, equivalent to an increase in voltage which, in the present case, can be estimated as equivalent to an increase of about 20 K.V. The decreased stress upon the x-ray tube and the apparatus are again advantages obtainable through efficient filtration.

These advantages, however, are assured only if the metal thickness, the purity and density of the metals, and the order in which they are placed relative to the direction of the rays, are correctly selected. It appears that, in particular, impurities in filtering metals, as well as non-definite densities, are factors which very often are neglected, but which are of great importance with respect to compound filters. Each metal should be tested with x-rays as to its absorption, coefficient, and its thickness which is best calculated from the mass absorption coefficient. It is justified to say that, unless all these conditions are fully complied with, the advantages of composite filters may be lost.

A composite filter for radiations between 140 and 200 K.V. shows distinct merits over a single metal filter, provided

it complies with all the conditions pointed out. For radiations above a 200 K.V. another composite filter, including an additional metal higher than Sn in the atomic series, *i.e.*, Ta or W, is to be placed near the tube.

D. SUMMARY

1. The advantages of using filters consisting of several metals are pointed out.

2. It is shown that the direction of the rays through composite filters must be in the order of the atomic numbers, beginning with those having the highest number.

3. By means of absorption curves, spectrograms, and depth dose measurements, it is shown that composite filters are capable of giving larger depth dose ratios and smaller average absorption coefficients, with a given radiation, than single filters (such as Cu) alone.

4. With a composite filter, a radiation is obtained corresponding to approximately 10 per cent higher voltage than the same radiation filtered through Cu.

5. Two practical filters are recommended—one for radiations from 100 to 200 K.V., and the other for radiations above 200 K.V.

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THE SPECTROPHOTOMETRIC ANALYSIS OF THE COLOR OF THE SKIN FOLLOWING IRRADIATION BY ULTRA-VIOLET RAYS[1]

By JAMES R. ROGIN, M.D., M.S.,[2] Fellow in Dermatology, *and* CHARLES SHEARD, PH.D., Division of Physics and Biophysical Research, *The Mayo Foundation, Rochester, Minnesota*

ACCURATE analysis of the color of the skin by use of the spectrophotometric method was carried out some years ago by Sheard (11), Sheard and Brown (12), and Brunsting and Sheard (2, 3). Harris, Leddy, and Sheard (4) used this method in an investigation concerning the erythema and pigmentary changes in the skin following irradiation by roentgen rays. The present investigation was undertaken to determine, through the use of the spectrophotometer, the changes in color which take place in the skin following irradiation by ultra-violet rays.

The details of construction and operation of the spectrophotometer (Keuffel and Esser Color Analyzer), and the principles underlying its use in the analysis of the color of the skin are to be found in the papers by Sheard and his collaborators. By adding a water-cooled cell, Brunsting and Sheard (1) found it possible to examine living tissues spectrophotometrically without subjecting them to changes which might be induced by thermal radiation from the sources of light (two 400-watt lamps) in the apparatus used.

SPECTROPHOTOMETRIC METHOD AND COLOR NOMENCLATURE

The analysis of color as made from the data obtained by spectrophotometry is a direct and accurate method for the quantitation of color in terms of its fundamental attributes, namely, hue, brilliance, and purity. Much information may be gathered from the plotting of curves showing the relationship between spectral wave length and percentage reflection, and directly comparing the curves from corresponding areas of skin of different persons. However, if it is desired to describe accurately the color stimulus received by the observer in terms of the color excitation values (red, green, and violet), relative luminosity, and purity, it is necessary to make an analysis of any spectrophotometric reflection curve into its fundamental attributes of color. Such an analysis gives a scientifically correct description of the color as it appears to the eye under noonday sunlight. By suitable computations (12) the spectrophotometric data may be converted so as to express these characteristics of color in universal values.

The brilliance, or relative luminosity (often spoken of as brightness, tint, or value), defines the proportion of the total amount of standard white light which the material under test is capable of reflecting. In this manner, the brilliance of the material may be classified as equivalent to some member of a series of grays, of which black and white are the extremes.

The fundamental hue or dominant wave length refers to that attribute of color by which it may be classed as reddish, yellowish, greenish, or bluish. The hue depends on the wave length only.

The purity or saturation of a color defines the degree of hue which any color possesses. This attribute expresses the vividness or distinctness of a color, and defines how red or how yellow, and so forth, a color is. The Committee on Colorimetry of the Optical Society of America has discussed these and related subjects in complete detail, and for further details reference may be made to its report (14).

THE SPECTROPHOTOMETRIC ANALYSIS OF THE COLOR OF THE SKIN

In normal subjects Sheard (11), and Sheard and Brown (12), found that the

[1] Abridgment of thesis submitted by Dr. Rogin to the Faculty of the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of Master of Science in Dermatology. Work done in the Division of Physics and Biophysical Research. Submitted for publication Feb. 12, 1934.

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dominant wave length, purity, and percentages of red, green, and violet excitation values, respectively, remained fairly constant. The value for relative luminosity varied according to the amount of pigment present in the skin. Subjects with much pigment in the skin reflect less light than those with little pigment in the skin. Thus the values for relative luminosity in the skin of a negro will be low, while they will be much higher for the skin of a blond individual. The values of the relative luminosity for the skins of brunets of the white race fall between those for the blond and the negro. Variations in the amount of pigment do not affect either the dominant wave length (which is usually in the region of spectral yellow, 590 millimicrons) or the value for the purity or saturation (which is approximately from 40 to 50 per cent). Brunsting and Sheard studied the color factors of the skin of various races, including whites, negroes, Chinese, and Indians, and found that they differ chiefly in the amount of pigment which they possess. The amounts of pigmentation may be taken as the reciprocals of the values of the relative luminosities. These relative luminosities varied from 46 per cent in the blond to 7 per cent in the negro. In all cases, the values for dominant wave length and purity of the color of the skin of the different races were approximately the same.

Brunsting and Sheard also studied the part played by the superficial blood in the color of the skin. By comparing the reflection curves from the skins of living subjects with postmortem specimens from which the blood had been removed, they attributed the zones of decreased reflection which they found in normal skin in the regions 540 and 580 millimicrons to the presence of blood in the superficial capillaries, since these absorption bands correspond to those given by oxyhemoglobin. They also found that when there is an increase in the quantity of blood near the surface of the skin, there is a decrease in the value of the relative luminosity just as there is when the amount of pigment is increased in the skin. However, in addition to the decrease in the value of the relative luminosity, the increase in superficial blood causes other changes which an increase in pigmentary content does not produce.

When there is an increase in oxygenated blood, there is a shift in the dominant wave length from the normal spectral yellow region of 590 millimicrons toward the orange or red end of the spectrum at from 620 to 660 millimicrons. At the same time there is a decrease in the value of the purity or degree of hue. If there is an increase of venous blood near the surface of the skin, as in cyanosis, the dominant wave length shifts toward the blue region of the spectrum at from 490 to 500 millimicrons.

The results of Brunsting and Sheard indicate that a decrease in the value of the relative luminosity, without an accompanying change in the other two fundamental attributes of the color of the skin, signifies an increase in the pigmentary content of the region under investigation. The relative luminosity values may be used, therefore, as a measure of the pigmentary content of the skin. The percentage of red excitation values serves as an index to the degree of erythema present in the skin. The value of the purity also might be used for this purpose, since the values of the purity usually follow quite closely the course of the red excitation values. However, the use of the red excitation values appears to be more logical when referring to degree of erythema. Harris, Leddy, and Sheard used these values in this manner in their investigation of the erythema and pigmentary change of the skin following irradiation by roentgen rays. We have followed the same procedure in this investigation.

EXPERIMENTAL PROCEDURE

The skin of the volar aspect of the forearm was used in these spectrophotometric examinations. This region was selected because of its accessibility, and because

there is practically no hair on the volar aspect of the forearms of most persons. (When a great deal of hair is present, philis, but were entirely free from cutaneous eruptions of all types. It was decided to use these patients as subjects

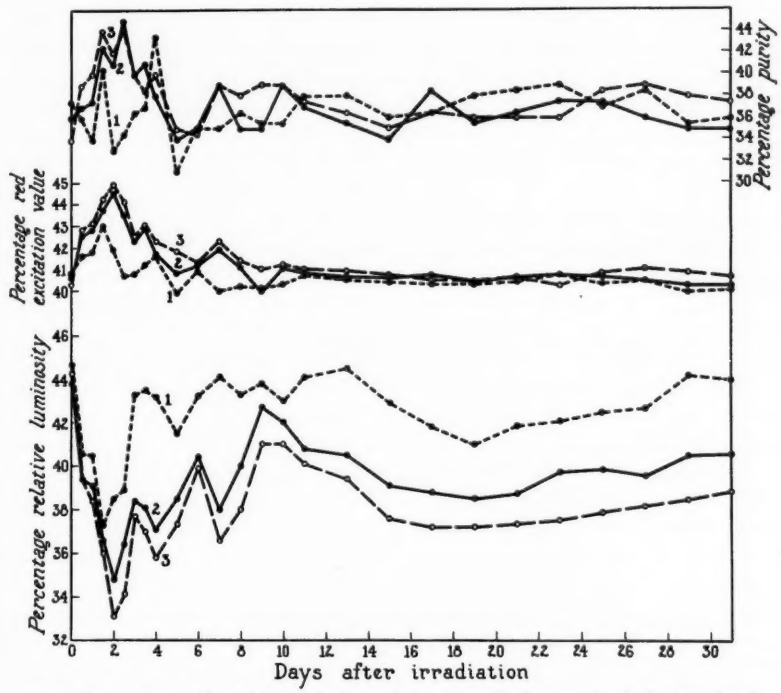

Fig. 1 (Experiment 1). Curves of the purity, red excitation, and relative luminosity values. Same dosage of ultra-violet radiation. Curves marked 1, area moistened with oil of bergamot; curves marked 2, area moistened with 10 per cent alcoholic solution of oil of bergamot; curves marked 3, area directly irradiated.

especially if it is dark, the value for relative luminosity is markedly reduced.) The subject's arm rested on an adjustable support and was usually in the same position at each examination, that is, at about the level of the heart as he was seated at the instrument. A sandbag placed against the arm served to hold it in the correct position before the aperture in the spectrophotometer.

The investigation was conducted during the summer, and the subjects chosen were all males who could keep their forearms covered and thus protect the areas under examination from exposure to sunlight throughout the course of the investigations. All the subjects had latent syphilis, but were entirely free from cutaneous eruptions of all types. It was decided to use these patients as subjects since they had available the time necessary for the daily spectrophotometric examinations, as they remained at the clinic for antisyphilitic treatment. It was felt that neither the presence of syphilis nor the treatment instituted would alter the results of the investigation in any way.

Spectrophotometric readings of the skin in each area were made immediately before irradiation. Stencils of pliable tin were used to block off the areas to be irradiated, and at the same time to protect the rest of the skin of the arm. The size of each area irradiated was 3.5 by 4 cm., and this was large enough to cover the aperture in the spectrophotometer. The dosage of ultra-violet irradiation employed previously had

been found to produce moderate erythema in normal skin.

The next spectrophotometric reading ordinarily was made about six hours after irradiation. By this time erythema usually had appeared. Readings were then made twice daily for the next five or six days, then once a day for the next week or ten days, and finally every other day for the remainder of the tests. The spectrophotometric readings were continued from four to five weeks.

Three areas of skin of each patient were exposed to ultra-violet radiation. One area was moistened with oil of bergamot before irradiation. A second area was moistened with a 10 per cent alcoholic solution of oil of bergamot before irradiation. The third area, subsequently referred to as the control area, was a portion of the untreated skin. All three areas were then exposed to the same dosage of ultra-violet radiation. It was found that the solutions which were applied before irradiation acted as absorbing media to the ultra-violet rays. The oil of bergamot reduced the dosage to a greater degree than did the alcoholic solution of the oil of bergamot. In effect, then, each patient was exposed to three dosages of ultra-violet irradiation of different intensity.

EXPERIMENTAL DATA AND RESULTS

Experiment 1.—The subject (Fig. 1) was a man, aged 63 years, with blue eyes, medium brown hair, and fair skin on unexposed parts. The skin was exposed to ultra-violet radiation from the quartz mercury lamp for two minutes, operated at 125 volts and at a distance of 30 centimeters. Five hours later erythema had appeared in all three areas, but was definitely least marked in the area which had been moistened with oil of bergamot before the irradiation. This difference in degree of erythema was easily perceptible to the naked eye. However, it was impossible to discern any difference between the remaining two areas by visual observation alone. Spectrophotometric analysis disclosed that the greatest erythema, as measured by red excitation units (Fig. 1), appeared in the control area to which no solution had been applied.

The peak of the erythema was reached in the area to which oil of bergamot had been applied twenty-nine hours after irradiation. The curve showing the red excitation values falls rapidly from this point. Schall and Alius found this sharp rise and sharp decline in 39.5 per cent of the cases in which they studied the course of the erythema produced by ultra-violet irradiation. They described it as a "crisis-like" reaction.

As the course of the erythema was followed in this irradiated area from day to day, secondary maxima appeared, the peaks of which were reached on the fourth, eleventh, and twenty-third days after irradiation. The curve for purity values follows closely, but in more accentuated form, that for the red excitation values. The curve for relative luminosity drops sharply immediately after the irradiation, and reaches its lowest point when the value for red excitation is at its peak. As the red value falls, the curve for relative luminosity rises, and, with several lesser secondary drops in value, it continues to rise until the thirteenth day, from which time on it declines steadily until the nineteenth day. From this point the curve gradually rises until the investigation is concluded on the thirty-second day.

The red excitation value for the area to which the alcoholic solution of oil of bergamot had been applied before irradiation revealed an early rise which reached its maximal value forty-seven hours after irradiation. From this point it declined sharply, again crisis-like, but exhibited secondary rises, the peaks of which occurred seventy-seven hours after irradiation, and also on the seventh, tenth, seventeenth, and twenty-third days. As was found in the area previously examined, the purity values again followed closely those for red excitation. The value for relative luminosity in this area dropped sharply from the onset, and reached its lowest point at the time the value for the

red excitation was the highest, or forty-seven hours after irradiation. With several lesser secondary drops, the curve then the value for red excitation. Also the curve for relative luminosity was rhythmic (wave-like), with low points forty-seven

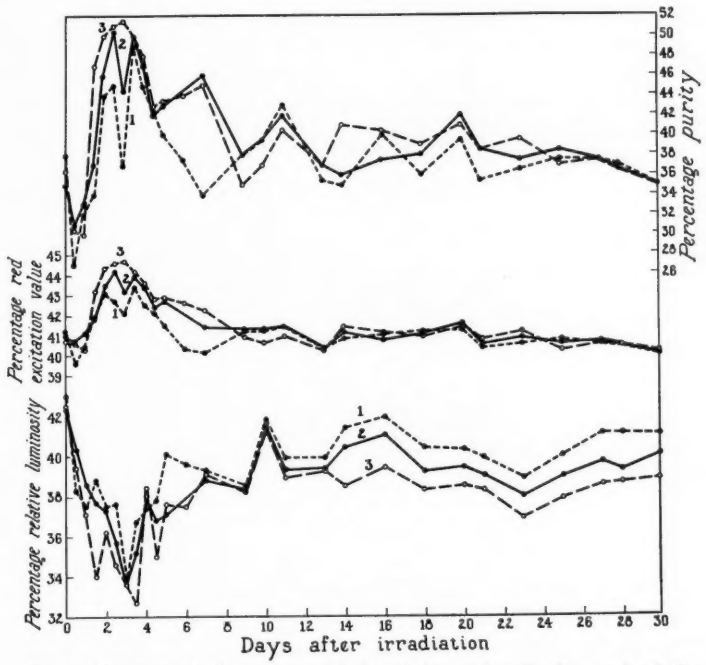

Fig. 2 (Experiment 2). Curves of the purity, red excitation, and relative luminosity values. Same dosage of ultra-violet radiation. Curves marked 1, area moistened with oil of bergamot; curves marked 2, area moistened with 10 per cent alcoholic solution of oil of bergamot; curves marked 3, area directly irradiated.

gradually rose until the ninth day, after which it declined steadily until the nineteenth day; this marked the beginning of a gradual rise in value which persisted until the end of the investigation.

The control area, not treated with oil of bergamot, but exposed directly to ultra-violet radiation, revealed a greater increase in red excitation values than occurred in either of the other two areas. This curve was also crisis-like, with its highest point forty-seven hours after irradiation and with secondary peaks on the seventh, tenth, twenty-first, and twenty-seventh days after irradiation. As in the two areas previously studied, the curve for the purity value again followed closely hours after irradiation (when the value for red excitation was the highest), and with other low points four, seven, and nineteen days following irradiation. From the nineteenth day to the conclusion of the investigation on the thirty-second day the value for relative luminosity increased steadily.

The values for green excitation units changed but little throughout the course of the entire investigation, whereas the values for violet excitation bore somewhat of a reciprocal relationship to those for the red; that is, when the values for red were high, the values for violet were low, and *vice versa*. The dominant wave length varied between 582 and 593 millimicrons. In most instances the value of the domi-

nant wave length was found to be near 585 millimicrons, and the slight deviations from this value seemed to bear no relationship to changes in the values for the other nosity, whereas the value for the area to which oil of bergamot had been applied lies between the values found for the other two areas.

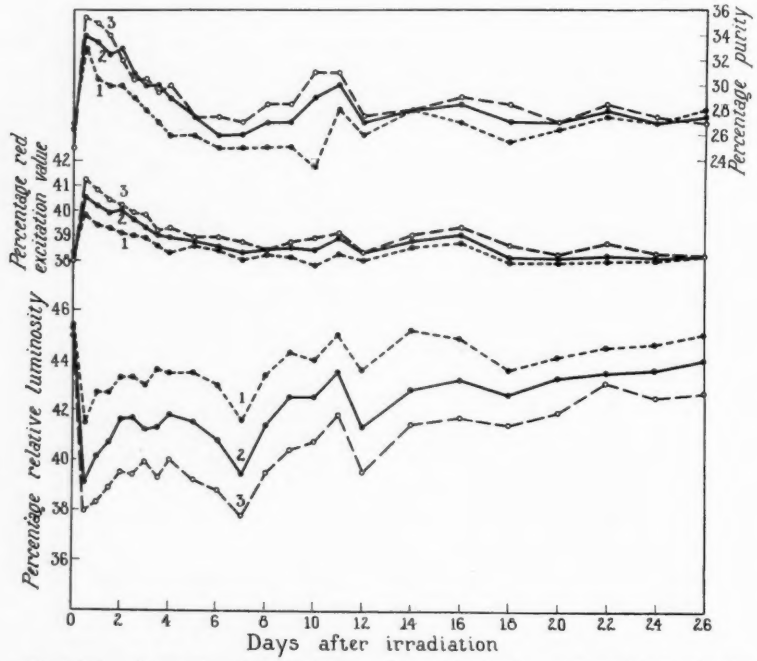

Fig. 3 (Experiment 3). Curves of the purity, red excitation, and relative luminosity values. Same dosage of ultra-violet radiation. Curves marked 1, area moistened with oil of bergamot; curves marked 2, area moistened with 10 per cent alcoholic solution of oil of bergamot; curves marked 3, area directly irradiated.

attributes of color, that is, purity or relative luminosity.

Comparing the results from the three areas of the subject examined, it is seen that the greatest erythema (red excitation value) is found in the control area, and that the erythema of the area to which the alcoholic solution of oil of bergamot had been applied was only slightly less. The erythema in the area to which the oil of bergamot had been applied was distinctly less than that in the other two areas.

The curves for relative luminosity, representing degree of pigmentation, bear a reciprocal relationship to the erythema or red excitation values. The control area shows the lowest value for relative lumi-

The results for the remaining subjects examined are quite similar to those obtained in the case of the subject (Experiment 1) which we have reported in some detail. Graphical results of data obtained in certain additional subjects are presented in Figures 2 to 6. It is necessary to comment only briefly on a few of the features revealed by these investigations.

Experiment 2.—The subject (Fig. 2) was a man, aged 53 years, with medium brown hair, blue eyes, and fair skin. This subject was exposed to ultra-violet radiation from the quartz mercury lamp for three minutes, operated at 125 volts and 30 cm. distance. The curves for red excitation values for the areas to which

oil of bergamot and the alcoholic solution of oil of bergamot had been applied exhibited a distinct decrease seventy-two hours after irradiation, followed by a sharp rise six hours later. Such curves fall into the "double crises" group of reactions which Schall and Alius found with 20.5 per cent of their patients. The red excitation curve in the control area was higher than that in either of the other two, and although the peak was somewhat rounded, it undoubtedly may be classified as indicating a crisis-like reaction. The curves in all these areas were definitely wave-like or rhythmic, with from three to five lesser secondary maxima during the course of the investigation as continued for thirty days. The curves revealing the purity also paralleled the curve for red excitation values. The curves for relative luminosity revealed the initial sharp drops also found with the previous subject. The values gradually rose as the values for the red excitation decreased. Several definite secondary waves in the value of the relative luminosity were noted during the course of the experiment. The highest erythema (red excitation units) occurred in the control area and the lowest relative luminosity value, representing the greatest pigmentation, also occurred in this same area. The lowest erythema value was found in the area to which oil of bergamot had been applied, and it was in this area that the least pigmentation, or highest relative luminosity value occurred. The values for red excitation and relative luminosity for the area to which the alcoholic solution of the oil of bergamot had been applied were between the values for the other two areas.

Experiment 3.—The subject (Fig. 3) was a man, aged 35 years, with dark brown hair, brown eyes, and very fair skin. He was exposed to ultra-violet irradiation from the quartz mercury lamp for three minutes at 125 volts and 30 cm. distance. The red excitation curves were crisis-like in all three areas. The erythema and pigment values were highest in the control area and lowest in the area to which oil of bergamot had been applied. The values for the area to which the alcoholic solution of the oil of bergamot had been applied lay between those for the other two areas. The curves for purity, red excitation, and relative luminosity for the three areas were definitely wave-like.

Experiment 4.—The subject was a man, aged 27 years, with dark brown hair, blue eyes, and moderately dark skin. He was exposed to ultra-violet irradiation from the quartz mercury lamp for five minutes at 125 volts and 30 cm. distance. The erythema reaction was crisis-like, and evidence of rhythmicity was present in each curve.

Experiment 5.—The subject was a man, aged 48 years, with dark brown hair, brown eyes, and fair skin. He was exposed to ultra-violet irradiation from the quartz mercury lamp for four minutes at 125 volts and 30 cm. distance. The curves for red excitation values rose rapidly, and were sustained for approximately one hundred hours before falling. This curve was of the plateau type which Schall and Alius found in 12.5 per cent of their cases. There were only two secondary waves and these also tended to be sustained. The curves for relative luminosity values also revealed division into definite wave-like periods.

Experiment 6.—The subject was a man, aged 50 years, with dark brown hair, blue eyes, and medium complexion. He was exposed to ultra-violet irradiation from the quartz mercury lamp for two minutes at 125 volts, 30 cm. distance. The curve for red excitation in the area to which oil of bergamot had been applied was crisis-like, and did not rise nearly as high as those in the other two areas. The curves for red excitation value in the other two areas were definitely of the double-crisis type, with the first peak occurring about twenty-four hours after irradiation and the second one about ninety-six hours after irradiation. Evidence of a rhythmic phenomenon was present in all three areas in the curves for red excitation, purity, and relative luminosity.

Experiment 7.—The subject (Fig. 4) was a man, aged 47 years, with medium brown hair, blue eyes, and very fair skin. He was exposed to ultra-violet irradiation from the quartz mercury lamp for three minutes, at 125 volts and 30 cm. distance. The red excitation curve for the area to which oil of bergamot had been applied was definitely of the plateau type. Secondary waves were present and the final wave which occurred from the tenth day to the conclusion of the investigation reached its maximum at the thirteenth to the fifteenth day. At this point the red excitation value was higher than the original increase obtained immediately after the irradiation. Such exaggerated delayed reactions are quite common following irradiation by roentgen rays (Harris, Leddy, and Sheard), but occurred in only this one area of the twenty-seven which were irradiated during this investigation. The curves for the red excitation values for the region to which the alcoholic solution of the oil of bergamot had been applied and the control area were crisis-like, and exhibited high and long-sustained secondary waves. The rhythmic phenomenon was present in the curves for all three regions.

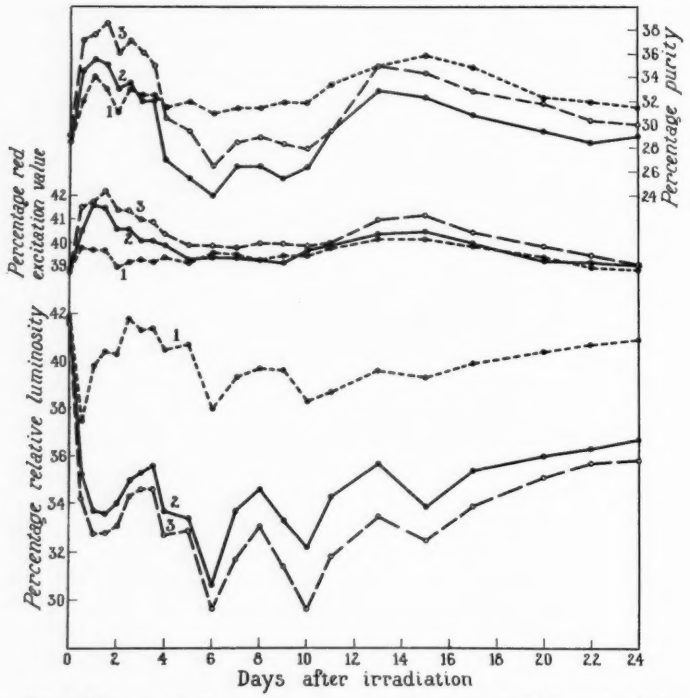
Percentage red excitation value
Percentage relative luminosity
Percentage purity
Days after irradiation
0 2 4 6 8 10 12 14 16 18 20 22 24
42 41 40 39
42 40 38 36 34 32 30
38 36 34 32 30 28 26 24
1
2
3

Fig. 4 (Experiment 7). Curves of the purity, red excitation, and relative luminosity values.

Experiment 8.—The subject (Fig. 5) was a youth, aged 17 years, with dark brown hair, brown eyes, and swarthy complexion. He was exposed to ultra-violet irradiation on three different occasions. The initial exposure was preceded by applications of oil of bergamot in one area and alcoholic solution of oil of bergamot in a second area. The succeeding irradiations were given without applying solutions to any of the areas. The initial reaction revealed a sharp rise, which reached its maximal value six hours after

irradiation and then dropped rapidly. This rapid fading of the erythema probably is explained by the protective action afforded by the patient's swarthy complexion. A second and larger dose of ultra-violet irradiation given on the ninth day produced the highest erythema in the area to which oil of bergamot had been applied before the first irradiation. On the first occasion this area had exhibited the lowest erythema and least pigmentation. A third and still larger dose of ultra-violet irradiation given on the tenth day after the first irradiation again produced only a very slight rise in erythema, as measured by red excitation units. Apparently the pigment produced by the first ultra-violet irradiation acted as a protection against the subsequent exposures, since the larger doses gave much smaller erythemic reactions than did a much smaller dose applied to a non-irradiated (normal) part of skin. This observation is in agreement with the commonly accepted statement that normally dark-skinned persons, or those with sun-tanned skins, are not as prone to sunburn as are those not tanned, or blond persons.

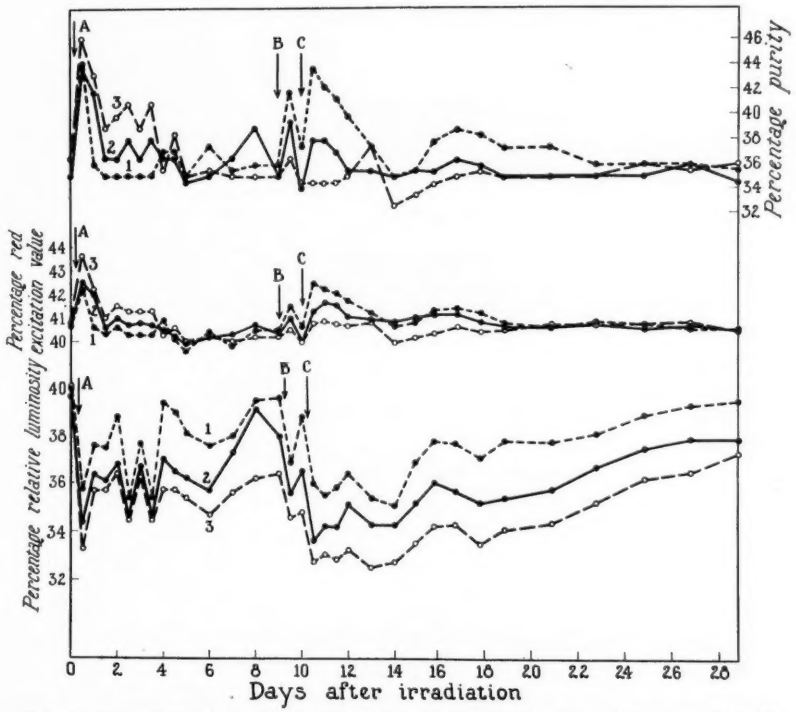

Fig. 5 (Experiment 8). Curves exhibiting the values of the purity, red excitation, and relative luminosity. At *A*, ultra-violet irradiation (125 volts, 30 cm. distance for two minutes) preceded by application of oil of bergamot in one area (Curve 1), 10 per cent alcoholic solution of oil of bergamot in another area (Curve 2), and a control area (directly irradiated) (Curve 3). At *B*, ultra-violet irradiation (125 volts, 30 cm. distance for four minutes) only. At *C*, same as in *B*, with time of exposure ten minutes.

Experiment 9.—The subject (Fig. 6) was a man, aged 22 years, with blond hair, blue eyes, and fair skin which was well tanned from previous exposure to sunlight. He was exposed to ultra-violet irradiation in three different areas on the forearms. The curves for the red excitation values exhibited crisis-like reactions in all three

areas. The highest value of red excitation was obtained from the area that had been exposed for the greatest length of time, and the lowest value was obtained from the area which had received the least ultra-violet radiation. As has been shown in the data obtained from other subjects, the values for relative luminosity were inversely proportional to the values for red excitation. Definite evidence of rhythmicity was present in all three areas.

RHYTHM IN THE COURSE OF ERYTHEMA AND PIGMENTATION

Further analyses of the spectrophotometric data reveal that the initial erythema reaction could be classified according to Schall and Alius as crisis-like in nineteen of the areas studied, plateau-like in four, and double crisis-like in four.

Schall and Alius (8), and Schall (9) found marked individual variations in the course of the erythema following ultra-violet irradiation. However, they noted definite evidence of a wave-like phenomenon, as described by Miescher and others following roentgen irradiation, in 62 per cent of 55 cases studied. They found a suggestive wave-like reaction in an additional 14 per cent of their cases, whereas in only 24 per cent this phenomenon was absent. The number of waves in each case was variable, but their paper contains a chart revealing from two to three definite waves within the first 134 hours after irradiation.

Schwarz believed that a secondary period of latency was not limited to erythemas following roentgen or ultra-violet irradiation. He found a wave-like phenomenon in the course of the erythema of mustard oil dermatitis. He stated that it is probably also present in other biologic reactions, such as in the tuberculin reaction. According to his results, the waves in mustard oil dermatitis occur over a period of hours rather than weeks, as is the case following roentgen irradiation. He advanced no evidence for a wave-like phenomenon following ultra-violet irradiation.

Pohle studied the skin by means of the capillary microscope after a single exposure to a medium erythema dose of ultra-violet rays. He made observations two, six, twenty-four, forty-eight hours, and two weeks after irradiation. At the end of two weeks' time there was no pigmentation, and the capillaries had returned to normal. He concluded from his investigations that the effect of ultra-violet irradiation on the capillaries was brief and temporary, and that there was only one cycle.

Evidence of a wave-like phenomenon in the course of erythema and pigmentation was present in each of the twenty-seven areas studied in this investigation. The individual variations in the time of occurrence of the waves were so great that no attempt has been made to classify the waves according to the intervals of time at which they occurred. In this respect the reaction following ultra-violet irradiation is apparently somewhat different from the effects of roentgen irradiation, in which the reaction may be divided into at least three waves occurring at more or less definite intervals of time. The same dosage of ultra-violet irradiation was given on only three occasions during the present investigation, and conclusions regarding definite intervals of time for the waves can scarcely be drawn from such a small series. There is need for further investigation in this direction, using a constant dosage of ultra-violet irradiation in a large series of cases.

The amount of pigmentation which occurred in an irradiated region was directly proportional to the degree of erythema which had occurred in that region. This was true only when different regions in the same subject were compared (Experiment 9). Such a statement cannot be made when comparing the erythemas and pigmentation of different subjects. A high degree of erythema might result in deep pigmentation of one subject, whereas approximately the same degree of erythema might produce only slight pigmentation of another subject. These observations, of the marked individual variations in erythema and pigmentation following

irradiation by ultra-violet rays, have been noted repeatedly in the literature, and have been confirmed spectrophotometrically in the present investigation.

In general, the course of the values for relative luminosity was also wave-like, but the waves were usually independent of those for red excitation. However, there was an initial sharp drop in the value for relative luminosity, which reached its minimal point at approximately the same time that the value for red excitation was at its maximum. Then, as the erythema faded, the value for relative luminosity increased. Brunsting and Sheard have shown that an increase in the quantity of blood in the peripheral vessels would reduce the value for relative luminosity. This probably is the explanation for the initial sharp drop in value for relative luminosity. Since there was practically no change in the dominant wave length (hue) in any of the areas studied, the erythema must be due chiefly, if not entirely, to an increase in quantity of blood in the peripheral vessels. The quality of the blood remains unchanged in respect to its oxygen content. This statement is made on the basis of observations by Brunsting and Sheard that a reduction in the oxygen content of the blood, as in congestion (an increased amount of venous blood), causes a shift in hue toward the blue end of the spectrum, whereas an increase in the oxygen content of the blood as in hyperemia (an increased amount of arterial blood) causes a shift in hue toward the red end of the spectrum. Since no change in hue of the irradiated areas occurred at any time during the investiga-

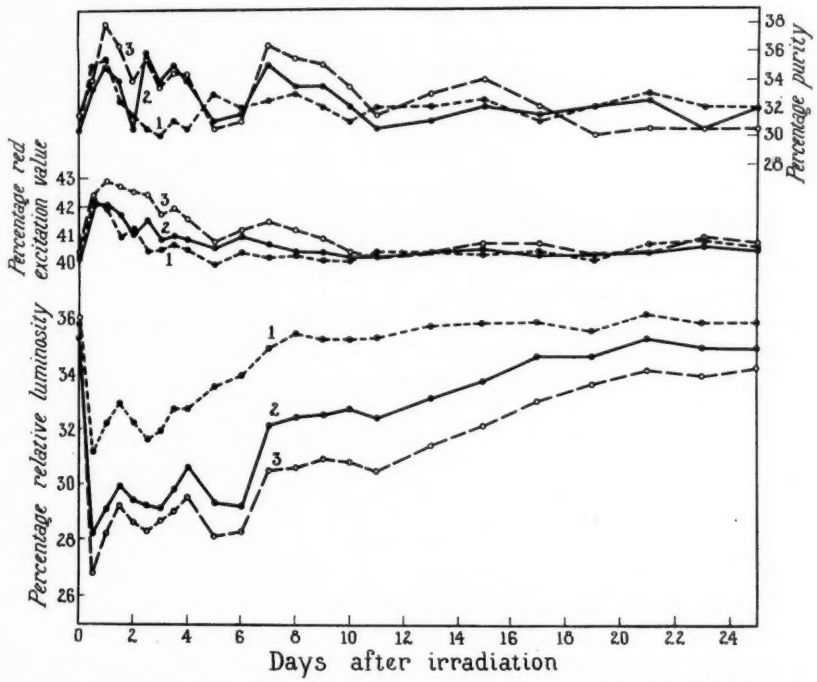

Fig. 6 (Experiment 9). Curves showing the values of the purity, red excitation, and relative luminosity. Ultra-violet irradiation (125 volts, 30 cm. distance) five minutes' exposure (Curve 1); eight minutes' exposure (Curve 2); eleven minutes' exposure (Curve 3).

tion, it must be concluded that the increased redness which follows irradiation is due to an increased amount of normal blood in the periphery. This is accomplished by an increase in the number of open capillaries, and also by a more complete dilatation of capillaries already open. Harris, Leddy, and Sheard have advanced this explanation for the erythema which follows roentgen irradiation. Such a conclusion is further supported by the work of investigators who have studied the capillaries of the skin.

After the relative luminosity value has recovered from its initial sharp drop, the curve continues independently of that for the red excitation value. Its course varies markedly in different subjects, but exhibits definite rhythm in all cases, indicating a peculiar lability in the pigmentary function of the skin. The variations from time to time may be explained in part by the differences in the amounts of scaling which occurs normally at all times, the pigment being carried off in the scales. Such changes are particularly marked during very hot weather, when increased perspiration carries with it an increased amount of the superficial layers of the skin.

CONCLUSIONS

1. The use of the spectrophotometer affords an accurate method of recording the changes of color in the skin after ultra-violet irradiation.

2. The initial erythema reaction of the skin following such irradiation is generally crisis-like, but may also be plateau-like or double-crisis-like.

3. The course of the erythema is rhythmic or wave-like, persisting for weeks.

4. In the same subject, the amount of pigment formed after ultra-violet irradiation is directly proportional to the degree of the preceding erythema. This statement cannot be made, in the light of the data at hand, when comparing the erythema and the pigmentation following ultra-violet irradiation among different patients.

5. The pigment follows a rhythmic course, apparently independent of the course of the erythema.

6. There are marked individual variations in the chronology of the waves which appear during the course of erythema and pigmentation.

7. The fundamental hue or dominant wave length of the skin following ultra-violet irradiation remains constant.

8. The changes in redness of the skin following ultra-violet irradiation are due to changes in purity (saturation) of the hue.

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MAY PHYSICIANS, MEDICAL WRITERS, AND PUBLISHERS GIVE PUBLICITY TO RECOGNIZABLE PHOTOGRAPHS OF PATIENTS WITHOUT INCURRING LIABILITY?

By I. S. TROSTLER, M.D., F.A.C.R., F.A.C.P., *Chicago*

IT makes very little difference whether a physician is a specialist or a general practitioner; whether he is an obstetrician, a roentgenologist, or a dermatologist; whether he is engaged in private practice, is a member of a clinical group, or whether he is a full-time employee of a firm or corporation, as long as he sees patients in the capacity of a physician, surgeon, or obstetrician, he is constantly and continuously facing matters which involve him in legal liability of some form.

In previous papers I have attempted to show that he is constantly involved in contractual relationships,[1] that he is at all times in danger of being involved in malpractice actions,[2] that he may be forced to give, without suitable compensation, what he has a right to consider his own property,[3] and in the following paragraphs I believe I show that he may be held liable on any one or more of three counts, if he shows or publishes portraits or likenesses of patients.

While I have put the title of this paper in the form of a question, I fully believe that the question is answered before it is asked.

The question as to whether we lay ourselves liable for damages when we show photographic likenesses, before and (or) after treatment, cinematographic films of operations, roentgenograms, etc., of patients has come up a few times in the courts in this country, and in these parlous times it behooves us to look well toward the rising sun each morning, in order to see, if possible, what the day may bring forth.

The recent filing and ultimate settlement out of court, by the payment of a considerable sum of money, of a suit wherein a physician was charged with showing a motion picture of a Cæsarean operation, makes this so much a live subject that, it is apparent, we should look around us and try to determine just where we stand.

Actions for damages, resulting from the unauthorized publication of photographs, have been based on one of three theories or combinations of them, namely:

1. That the publication is a libel. That it has exposed the person whose likeness has been published to ridicule, scorn, hatred, and public ignominy.
2. That the publication has been a trespass on the hypothetical right of privacy inherent in every individual.
3. That the publication was a violation of the law governing privileged communications, in such States as have privileged communication laws in force.

When the cause of the action has been based on the theory that publication has been libelous, something more than the mere publication of a statement, picture, or likeness must be shown. It must also be shown that the publication is in connection with matter that is either libelous on its face, or can be shown to be libelous by reason of inference that may be reasonably deduced by disinterested third parties or persons. If the picture or likeness be published in connection with any such libelous matter, then it is not material that the likeness be accompanied by the name or title other than that of the person portrayed, or even by no name at all.

In law, libel consists of publishing malicious statements, pictures, or caricatures with intent to expose persons or institutions to ridicule, scorn, contempt, or public hatred, and to thereby provoke them to anger, in that way causing a breach of the peace, injury to the reputation, business, etc., of the person, persons, or institution so libelled.

[1] Physicians and Contracts. Clin. Med. and Surg., August, 1932, XXXIX, 604–608.

[2] Medical Malpractice. Am. Med., July, 1932, XXVII, 7.

[3] The Expert Witness Fee. Am. Jour. Phys. Ther., December, 1928.

The difference between libel and slander is that, in libel, the defamation or the defaming statements, etc., must have been made or effected in writing, printing, picturing, caricaturing or by some other visible and (or) understandable manner; while in slander, the offence is committed verbally or by word of mouth only. In libel, *publication is held to have taken place if the libel is seen by one person other than the one libelled.*

If the charges contained in the libel are *true*, a civil action cannot generally be maintained, but the truth of the libelous matter is no defense at common law; at the same time, conviction generally secures for the defendant a merciful consideration of the court.

If in a civil suit for libel the defendant is found guilty, the amount of the damages is decided by the jury; but in a criminal libel case, the jury has only the authority to acquit or to find the defendant guilty. If found guilty, it becomes the duty of the court to pass judgment and award punishment.

The more recent legislation and decisions in regard to libel have a tendency to limit liability for action to purely false, malicious, and scandalous libels. Truth, if published with good intentions or motives and in pursuit of justifiable ends, is now generally admitted as a good defense, and even motive alone, though the statements may prove to be untrue, is generally admitted as a defense worthy of serious consideration.

The second cause for action, that of trespass on the right of privacy, involves a comparatively new legal principle over which a considerable amount of legal discussion has occurred and concerning which there appears still to be a considerable difference of opinion.

What is termed the right of privacy, on which some of these actions have been based, is the hypothetical right of every person to live his own life, free from public gaze or insight or public interference with his purely personal affairs; except, of course, so far as such public insight, gaze, or interference may be warranted or occasioned by the public interest or public welfare or by the public nature of the position, office, calling, or profession of the individual so portrayed.

The fact that there is some conflict in the opinions of the courts of several States as to the legal or logical existence of any such right makes it all the more important that we, as directly interested parties, make ourselves better able to discuss the subject and keep informed, insofar as we are able, in regard to the same.

The courts of Georgia, Kentucky, Louisiana, Kansas, Missouri, and Maine have recognized the legality and existence of the right of privacy. New York has a statute in force, specifically recognizing such a right. Courts in Michigan, Rhode Island, New York, and Washington have denied that right. Immediately after the New York court denied the right, the Legislature enacted the statute recognizing it, which is now in force, while in a case in Michigan, the right of privacy was recognized in a suit against a physician wherein a slight stretch of points involved might, and probably would, make this decision apply to this contention.

A case which attracted marked attention at the time is one which was tried in Savannah, Ga.,[4] wherein a child born with a developmental defect of the anterior thoracic wall so that the heart was visible, was taken to a hospital, where it died. The hospital authorities permitted photographs to be made of the body and these were published in the local newspapers. Action was brought against the hospital by the parents of the child, charging a violation of the right of privacy, their "right to have the extrinsic facts of the case kept secret and the child kept unexposed to public gaze and comment." A judgment was rendered against the hospital and it was affirmed by the Supreme Court of Georgia.

Recoveries have been allowed to plaintiffs for violation of their rights of privacy

[4] Basemore *vs.* Savannah Hospital (Ga.), 155 S.E.R. 194.

in printing or publishing of their photographs or of photographs of their children without consent in a number of cases, ten of which the writer is prepared to cite.

The doctrine that the right of privacy has been indirectly—and should be directly—protected by courts, primarily had its origin in "The Right to Privacy," a paper by Samuel D. Warren and Louis D. Brandeis, published in 1910 in the "Harvard Law Review." This paper has been called a "fountain-head of discussion, comment, criticism, litigation and perhaps even legislation." Since the last sentence was written it has been the cause even of legislation in New York. The authors, in the original article, pointed out that an action of tort for damages lies in all cases for the violation of the right of privacy without showing special damages.

It should be remembered that special damages may be of two kinds. In one instance special damages must be shown before there is a substantive right for action, while in the other, and this is the usual use of the phrase, special damages are additional damages over and above the ordinary loss which the plaintiff has sustained. It is to the first-mentioned instance to which reference as special damages for either libel or slander or the violation of the right of privacy applies.

Regarding this paper, Roscoe Pound, Dean of Harvard Law School, said: "What may almost be called the classical example of creative activity is the paper on 'The Right to Privacy,' in which Mr. Justice Brandeis, then at the bar, was a collaborator. A bit of juristic reasoning on the analogy of the legal rights that secure other interests of personality, showing that there was an interest or claim of privacy as a part of personality, and postulating a legal order that secures personality completely, created first discussion, then a conflict of discussions, and finally through decision or statute, a new chapter in the law of torts."

I quote from what appears to be the most celebrated and certainly the most quoted and leading case, that of Pavesich *vs.* New England Life Insurance Co.: "The right of privacy has its foundation in the instincts of nature. It is recognized intuitively, consciousness being the witness that can be called upon to establish its existence. Any person whose intellect is in a normal condition recognizes at once that, as to each member of society, there are matters private and there are matters public so far as the individual is concerned. Each individual as instinctively resents an encroachment by the public upon his rights which are of a private nature, as he does the withdrawal of those of his rights which are of a public nature. A right of privacy in matters purely private is, therefore, derived from natural law."

In the case of which the preceding quotation is a part of the final Supreme Court decision, the insurance company defendant published a recognizable picture of the plaintiff in an advertisement, together with statements purporting to have been made by him. The name of the plaintiff did not appear in the advertisement. The trial court, as well as the Supreme Court of Georgia, held that the plaintiff had cause for action for violation of his right of privacy as well as for libel.

Five States have given the right of privacy a common law standing, namely, Georgia (in 1905 and again in 1924), Kentucky (in 1909 and again in 1912 and 1927), Missouri (in 1911), Kansas (in 1918), and Maine. Louisiana recognized this right under its civil laws in 1905. The States of Michigan (1899), New York (1902), Rhode Island (1909), and Washington (1911), have refused to accept it as a common law right.

The decision in the New York case was decidedly unpopular and was bitterly criticized. As a direct reaction, a statute specifically recognizing the right of privacy was enacted by the New York Legislature within one year after the rendition of the decision. Decisions from Michigan and Washington were severely criticized in "10 Michigan Law Review, 335."

The decisions in the four States whose Supreme Courts refused to recognize the

right of privacy, stripped of extraneous discussion and legal verbiage, appear to base their refusal upon three reasons: First, lack of precedent; second, presumption that the injury in such cases is essentially to the feelings, for which the law, according to prevailing rulings (at that time), allows no recovery, and third, a fear (expressed and implied) that the recognition of the right of privacy would tend to bring out a vast amount of litigation.

The foregoing three reasons might be discussed at great length, but because they concern the legal side of this subject much more than they do the medical side, we will not enter into the discussion other than to state that such high legal authorities as Pound, Cardoza, Goodrich, Ragland, Chaffee, Long, Walsh, Lawrence, Clark, Bohlen and others definitely answer all the arguments which may be brought, and both directly and indirectly advance and advocate arguments in the direction of recognition of the right of privacy.

While it may be true that the right of privacy has been somewhat slow in gaining recognition by legislation and the enactments of statutes specifically recognizing the same, the common law principle brought out by the original article and the "judge made law" resulting from the growing number of decisions, is sure to bring the right of privacy to be recognized more and more as time goes on.

The Pavesich case, previously mentioned, is the first Georgia case; Itzrovitch *vs.* Whitaker was decided in 1907, in Louisiana, under the civil law. Here the State Supreme Court held that an injunction restraining a police officer from placing the photograph of an unconvicted prisoner in a rogue's gallery, was granted. The court said: "Every one who does not violate the law can insist upon being let alone (the right of privacy). In such case the right of privacy is absolute." Schulman *vs.* Whitaker was substantially a similar case and was likewise decided.

The first case to be decided in Kentucky, in which the right of privacy was recognized, involved an alleged testimonial for a patent medicine. The defendant company was alleged to have published a pamphlet advertising its products, which contained a forged testimonial purporting to have been signed by the plaintiff, Col. John P. Chinn. This read, "I join in endorsing Doan's Kidney Pills.... A few boxes effectively routed my ailment, and I am glad to acknowledge the benefit I have derived." Col. Chinn's picture was used, and he, incited by the chaff and banter of his friends and the hints and interjacence of others, became justly incensed and brought suit for $25,000 damages, asserting that he neither signed nor authorized the publication of his picture and that the publication damaged him by bringing him into ridicule. The trial court held that it was a question for the jury to determine whether the plaintiff had been subjected to ridicule, disgrace, odium, or contempt. If the jury so found, it would follow that there was a libel and damages would lie. But the court further held that the plaintiff was entitled to recover although the jury did find that the plaintiff had not been subjected to ridicule, odium, or contempt, *because of the violation and invasion of his right of privacy, whereby recovery may be had without proof of special damages.* Here the distinction between libel and the right of privacy is well brought out and shows how these may be applied.

This same case was again before the Court of Appeals of Kentucky in 1910 and the defendants refused to pay the judgment. Suit was then brought in the U. S. District Court at Buffalo, in 1912, and the decision of the Kentucky Court of Appeals was sustained. Defendants then took an appeal to the U. S. Circuit Court of Appeals, where the judgment was again upheld.

The second Kentucky case was decided in 1912 and was one in which a photographer was held liable for the publication of a photograph of the plaintiff's dead deformed child (a xiphophagus), contrary to agreement. There are apparently two

distinct bases for this decision—the violation of a contract and the violation of the right of privacy. The court considered that if the publication of a photograph of a living person is actionable (and quoted several decisions which of themselves are of no interest here), the same rule should apply to the publication of a photograph of the dead. This case was particularly interesting because it gave to the parents of the dead child the right of action, such right being generally considered to be personal and to die with the individual or person involved. But this court evidently—and wisely—considered that the parents as well as the child had a right of privacy which had been invaded and violated; thus indicating in a clear manner that there are separate rights, one to the child and the other to the parents.

In a New York case, the right of privacy was expressly placed on a property basis by an eminent jurist. While dissenting in the decision against the majority of the court in this case, Judge Gray, of the New York Supreme Court, said, "*I cannot see why the right of privacy is not a form of property.*"

ABUSE OR VIOLATION OF "PRIVILEGE" BY PHYSICIANS

The basis and theory that clinical photographs, case history records, roentgenograms, etc., are confidential and privileged communications bring up another, and to us a very important, point in connection with this subject. Might not a physician in permitting the publication of the photograph or other likeness of a patient make himself liable for action for damages because of his disclosing confidential or privileged communications in States which have privileged communication laws?

Very few cases appear to have been decided with respect to the extent and nature of a physician's liability for disclosing confidential or privileged communications and with respect to the nature of enforcing that liability. Such cases as have occurred and do exist in the records, are closely associated and combined with the disclosure of information that was libelous *per se*, so that they are not specific.

CONCLUSIONS

Five State Supreme Courts, having recognized the right of privacy as a substantive right, have rendered decisions to that effect, such recognition being based largely upon the arguments and reasons presented by Warren and Brandeis in the original presentation of the subject.

Contrary to these five States, four other State Supreme Courts have decided to refuse the right of privacy as a substantive right, but one of these States (New York) immediately enacted a statute recognizing that right. It appears that such refusal is based largely upon the lack of precedent and the fact that the injury in such cases is essentially an injury to the senses and feelings, for which the law is supposed not to allow recovery according to the prevailing rule. It is the apprehension by some of the jurists who wrote the decisions that recognition of the right of privacy would result in an enormous amount of litigation.

From the foregoing, it appears to the writer that we, as physicians, should be exceedingly careful not to lay ourselves liable to action for violation of the right of privacy by:

(1) Exhibiting recognizable photographs or likenesses of patients without their written consent;

(2) Being more than ordinarily careful regarding disclosures of privileged or confidential communications;

(3) Being exceedingly careful when describing cases, even to our colleagues, so as not to lay ourselves open to action for libel;

(4) Being careful and cautious to at all times respect what is sure to become

more and more recognized, namely, the right of privacy, and consequently more and more used by the sort of persons who sue members of our profession.

With such ordinary circumspection and restraint as we should at all times exercise, none of us will or should be held responsible for any of these torts or civil wrongs.

25 East Washington St.

PARATHYROIDISM: ITS LATE RESULTS[1]

By MAX BALLIN, M.D.,[2] *and* ARTHUR R. BLOOM, M.D., *Detroit*

THE history of parathyroidism, from the time Askanazy first mentioned the association of osteitis fibrosa cystica with parathyroid tumor, in 1907, and Mandl did the first parathyroidectomy for osteomalacia, in 1925, to the present, has been thoroughly discussed by Hunter, Barr and Bulger, Camp and Ochsner, Ballin and Morse, and others, therefore, this phase of the subject will not be taken up. These authors have also described the typical clinical symptoms of parathyroidism—localized pain, backache, decrease in height, tumor formation, pathologic fractures, the usual x-ray findings of demineralization, and hypercalcemia.

The roentgenologic findings are: (1) General or localized demineralization; (2) mottling of the bones by osteitis fibrosa cystica, usually "generalisata," but also localized at times; (3) deformities of the decalcified bones; (4) formation of larger cysts and giant-cell tumors in the bones; (5) fractures.

A review of a series of cases reveals that some of these various manifestations, which have formerly been classified as clinical entities, should have been diagnosed as cases of parathyroidism.

From a clinical point of view a few types may be distinguished.

1. The vertebral type, in which pain, deformities, osteitis fibrosa cystica, compression fractures, etc., are mostly pronounced in the spine.

2. The type with bone cysts (multiple and monostotic), in which giant-cell tumors and spontaneous fractures occur mostly in the long bones.

3. The infantile type, with chondromas, slipping epiphyses, and fractures. The beginning of symptoms in infancy is quite significant.

4. The arthritic type, in which the arthritis is the outstanding symptom but other symptoms speak for parathyroid origin.

5. Paget's disease.

This grouping is not a strict one; rather, overlapping between the different types is the rule. For instance, the vertebral type always shows changes in the skull, pelvis, and the extremities. Cysts and fractures are seen in this type, as well as in the second type, and *vice versa;* vertebral changes occur in the second type, and so on.

The generalized demineralization of the skeleton expresses itself on x-ray examination by lack of calcium; the bones have a washed-out appearance. In other instances, there are pin-point areas of decalcification, so that the bones seem to be granular or mottled. This is the roentgenologic expression of the pathologic entity of osteitis fibrosa cystica. Comparison of the plates with those of the same type of bones in individuals of the same age often gives the best judgment as to the degree of decalcification. The appearance of larger cyst formation in the bones and giant-cell tumors naturally shows itself by more or less round long defects in the lime-containing bony substance. At other times, the decalcification is so advanced that the contours of the bones can hardly be distinguished. The lessened lime content makes the vertebræ soft; they become compressed and wedge-shaped from the weight of the body, and the patients are stooped.

This condition injects an interesting factor in the determination of vertebral fractures from a medico-legal, as well as an academic, standpoint. Given a patient who has suffered a spinal injury, the film reveals compressed vertebræ, and we must

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[1] Read before the Radiological Society of North America, at the Eighteenth Annual Meeting, at Atlantic City, Nov. 28–Dec. 1, 1932.

[2] The death of Dr. Ballin took place in March, 1934.

determine, first if we are dealing with an out-and-out fracture, or, second, if this is a case of parathyroidism with vertebral collapse, but one in which the injury served only to call attention to the diseased spine, or, thirdly, if we are dealing with parathyroidism with soft vertebræ, in which a slight injury has caused a fracture.

Osteitis fibrosa cystica has definitely been proved to be due to parathyroidism, both experimentally and clinically. The injection of repeated doses of parathormone in animals has resulted in the typical x-ray and pathologic appearance of parathyroidism. Large numbers of parathyroidectomies have been performed, with recovery of the patient. The bone acts as the storehouse of the calcium for the body. Parathormone, either injected or secreted from a hyperfunctioning gland, removes the calcium from the spongiosa. Hemorrhages may occur in these areas, producing brown tumors and bone cysts characteristic of giant-cell tumors. Giant cells are found on microscopic examination.

FATAL CASES

Parathyroidism is recognized by all familiar with this entity to be a very dangerous, and frequently fatal, sickness. The patients die from exhaustion, due to pain and discomfort. Not infrequently decubitus ensues, due to the forced position the patients must assume, for they can hardly find a comfortable posture for weeks and months. In other cases, the deformity of the thorax leads to such diminution of the vital capacity of the lungs that death results from this and also from compression of the heart and large blood vessels (see Case 2). Other cases have been described in which severe vomiting, due to calcium deposits in the intestinal mucosa, etc., led to death. Nephritis, due to such deposits in the kidneys, is contributory to death (see Case 3).

AUTOPSY CASE

Case 1. Mrs. M. B., age 35 years. In 1914, the patient developed a swelling on the left forearm, followed by swellings along the ribs. A cyst formation was discovered in the forearm. Other foci of osteitis fibrosa cystica were found in the legs. The arms and legs were operated upon and the cysts curetted. In 1915, she was unable to walk and had to use crutches. She suffered considerably from pain in the spine and legs. A large fibroid was discovered in 1920. She died, in 1925, from an intestinal obstruction.

Autopsy showed all the bones very much thickened and irregularly deformed. The long bones, which showed bowing, could be bent like sole leather and cut easily with a knife. The cystic areas contained a soft, brown material. The periosteum was very thick. The calvarium which was 0.5 inch thick, cut easily. The left parathyroid contained a tumor. The bony swellings were typical giant-cell tumors.

While this patient died from an intercurrent intestinal obstruction, her miserable general condition, due to parathyroidism, prevented proper attention to her fatal complication. This case was not diagnosed—she died before the condition was generally known.

Case 2. (Fatal, not operated upon.) Mrs. L. A. M., age 45 years, had an extreme kyphosis of her softened spinal column, causing interference with the vital capacity of her lungs, described above. She had multiple fractures and many softened areas in the long bones and skull. Dr. R. C. Moehlig diagnosed the case properly, but, as operation at that time did not promise much, it was declined by the patient. The determination of her serum calcium and phosphorus and the roentgenographic films readily confirmed the diagnosis.

Case 3. Mr. H. J., age 65 years. The onset of symptoms was in 1926, when the patient complained of severe backache, leg ache, and curvature of the spine. His height diminished two inches. X-ray examination showed a destructive process and compression of the lower dorsal and upper lumbar vertebræ. A diagnosis of

metastatic malignancy was made; later, multiple myeloma was suggested. Still later, tuberculosis or syphilis of the spine was also considered. The man was entirely disabled and morphine had to be given freely. Later roentgenograms showed involvement of the second ribs, right femur, and compression of the intervertebral discs. Blood calcium: in 1929, 11.4; in 1930, 14.8. Urine: sugar, 4+; casts and albumin, 2+. There was evidence of metastatic calcification in the aorta. Dr. R. C. Moehlig made the correct diagnosis.

A parathyroidectomy was performed, an adenomatous parathyroid being removed. The result was splendid. The man came back from his previous invalidism to a fairly happy life. He discontinued his morphine, and was able to walk and travel again for 18 months, when a sudden uremic attack led to death.

Although, strictly speaking, this case should not be termed a post-operative fatality, death was due to nephritis caused by the hypercalcemia existing before the operation. The case is mentioned as a fatality to stress the fact that parathyroidism leads to nephritis by means of metastatic lime deposits in the kidney. Bulger, Barr, Dixon, and Schregardus also mentioned a case of parathyroidism in which the patient died from pyelitis 18 months after parathyroidectomy. He had had dysuria and skeletal symptoms 20 years before the operation.

Fatal cases from lime deposits in the gastric and intestinal mucosa, leading to uncontrollable vomiting, dehydration, etc., have been mentioned in the literature. (Charles Gibson's case vomited constantly for five weeks before the operation and died 18 hours after parathyroidectomy from the previously existing dehydration.) Almost identical cases have also been described by Ask-Upmark, R. M. Wilder, and others.

So far real parathyroidism has not been cured by medical means in spite of attempts by prominent internists (among them, Donald Hunter, Snapper, Wilder). If amelioration takes place, it is because either the relief is only of short duration, which is not unusual in endocrine disorders, or the symptoms are due to temporary disturbance from malnutrition (avitaminosis or a nutritional osteomalacia), which has been mistaken for real parathyroidism. Because the operative results, and perhaps also a few results from radiation, are quite striking, medical treatment should not be continued too long as serious deformities, renal lesions, etc., would prevent total recovery.

VERTEBRAL TYPE

Case 4. R. C., male, age 55 years. In January, 1930, the onset of the symptoms took place, consisting of backache and sacro-iliac distress. A diagnosis of sacro-iliac and vertebral hypertrophic osteoarthritis was made. However, the condition progressed and in May, 1930, there was a wedge-shaped fracture of the second dorsal vertebra, with general demineralization and marked pain. The height decreased 2.5 inches. The diagnosis of myeloma or metastatic malignancy was suggested. The man was disabled and required corset and crutches. The blood calcium varied from 11.3 to 18.6.

On Sept. 13, 1930 a bilateral thyroid lobectomy has performed and two parathyroids removed. Microscopy showed hyperplasia of the parathyroid tissue. The post-operative blood calcium varied from 13 to 10 mg., but it is now normal (August, 1932). There was a marked improvement in the lime content.

The patient has returned to work (May, 1931), gained 20 pounds, and still remains clinically cured, 26 months after the operation.

Case 5. Mrs. M. R., age 47 years. The onset of symptoms was in 1921, when the patient commenced to have backaches. In 1914 hysterectomy was performed. In 1929, the woman had a fall, resulting in what was considered a compression fracture of the eighth dorsal vertebra. A corset was used, giving temporary relief,

but soon she again complained of severe girdle pain, which was now more extensive.

Roentgenographic check-up of her skeleton showed a granular appearance of the skull, demineralization of all the bones, and compressions of the third, seventh, eighth, ninth, and tenth dorsal and the lumbar vertebræ. There was herniation of the nucleus pulposus in the mid-dorsal, lower dorsal, and all the lumbar segments. The blood calcium at different readings was 10.9, 12, 11, 9, 14, and 10.9. Operation was performed on Oct. 13, 1931, when an adenomatous goiter and two parathyroids were removed. The latter were transplanted in a tetany case with good results (physiologic test). There was immediate relief from pain and the patient was able to walk when she left the hospital. On Jan. 18, 1932, the woman was seen. She had gained much weight and was practically free of pain. The kyphosis has straightened out remarkably.

Case 6. F. O., age 40 years, reported during August, 1931, complaining of pain in the small of the back and both hips, weakness of legs and back and of tiring easily. The onset was sudden, while the man was playing ball. A frame and brace were applied.

Physical Examination.—Sept. 11, 1932. Kyphosis, tenderness of lumbar muscles, and rigidity of the back.

X-ray Examination.—Demineralization of ribs. Compression fracture of the eleventh dorsal vertebra and herniation of the nucleus pulposus. Irregular granular type of rarefaction of the skull, pelvis, and femora.

On March 5, 1932, subtotal thyroid lobectomy was done, with removal of the inferior parathyroid. The microscopic report was adenoma of the thyroid and hyperplastic parathyroid. Post-operative blood calcium, 8.6, 9, 4.11.

An Albee spinal graft was recommended to support the broken vertebra, as a corset gave the man no relief from pain. A general survey of the skeleton showed osteitis fibrosa cystica, which had progressed to the skull, and other areas of rarefaction. Since the parathyroidectomy, the patient has been able to work for five months and now, eight months after the operation, he has continued to be improved.

From these vertebral cases (Cases 3, 4, 5, and 6) the lesson should be drawn that, in vertebral compression of uncertain origin, general skeletal x-ray examinations, calcium studies, etc., are indicated. These may lead to the proper diagnosis of parathryoidism and at times prevent unnecessary operation. If the vertebral type is properly diagnosed in mid-life, good results are attained from removal of the offending parathyroid. It is the most frequent type seen at this age.

TYPES OF PARATHYROIDISM WITH BONE CYSTS, GIANT-CELL TUMORS, AND FRACTURES

Case 7. Mrs. M. M., colored, 30 years of age. The symptoms were first noted at 15 years of age, when there was a pathologic fracture of the left femur below the hip. A cast was applied and the patient was in bed for about eight weeks. In 1926, after myomectomy, the leg became painful, and pain developed in the left elbow. The woman had to use crutches and was confined to bed most of the time. X-ray examination revealed a cyst-like process with a pathologic fracture of the left femur, a smaller area of cystic changes in both iliac bones near the sacro-iliac synchondroses, and an avulsion fracture of the left elbow. The blood calcium was 11. The diagnosis was parathyroidism.

Operation was performed in February, 1931, a bilateral subtotal thyroid lobectomy being done, with removal of two inferior parathyroids. Microscopy showed adenomatous changes with large fat islands.

The post-operative course was good, with final recovery and the woman now walks without a cane. Roentgenograms reveal that the cysts have become smaller, and there is a slight increase in lime content.

Case 8. E. P., female, age 14 years, was operated on by Dr. G. Penberthy, after

consultation with one of us (M. B.). The child had been bed-ridden for a long time and decubital scars gave testimony of how profoundly sick she had been. Because of her age, the coxa vara, and numerous fractures, etc., she evidently belongs also to the infantile type, which we will describe later. But we have inserted her case on account of the giant-cell tumors, cysts, and fractures around her elbow which all practically disappeared after removal of an adenomatous parathyroid. The improvement could be seen by a comparison of the first and second films, which were taken before and after the operation.

In mentioning cyst formation in parathyroidism, it should also be stated that giant-cell tumors (18) and cysts of the jaw may be due to this disturbance. They have been cured by removal of hyperplastic or tumorous parathyroids, even though repeated curettements of the cysts have failed (Barr and Bulger, and Hunter).

INFANTILE TYPE

Many cases of parathyroid disturbances start early in life. One of us (M. B.) now has under observation a fully developed case in a girl 18 months old. The lesions, which are typical of the entity under discussion, are entirely different from rickets. A few cases show that first disturbances have taken place near the hip joint and neck of the femur, where weight-bearing obviously caused early deformity. Coxa vara, slipping epiphyses, "chondroma-like" formation, and cysts are often the diagnoses. At times, one leg is more affected than the other. A single bony involvement will hide at first a general affection ("arrested type of parathyroidism," Shallow). Our Cases 7 and 8 started as of the infantile type.

Case 9. B. N., a girl 5 years old, was first seen in 1927, at a time when little was known about parathyroidism. The outstanding symptoms then were shortening of the left leg, coxa vara, and fractures of the left femur and tibia. Biopsy of a bony swelling around the greater trochanter resulted in the report of chondroma. Orthopedic treatment, light, and dietetic measures did not stop the progress. More fractures of the tibia followed, the last one in 1931. After becoming familiar with parathyroidism, a further check-up showed that there was general roentgen evidence of osteitis fibrosa cystica, elevated blood calcium, and so on.

On March 31, 1932, two lower parathyroids were removed. The patient improved rapidly, and grew two inches in seven months following the operation. Recalcification of the whole skeleton was evident in roentgenograms, so that in September, six months after the parathyroidectomy, an osteotomy of the deformed femur could be done. There was good callus formation at the place of osteotomy, a process which had not occurred before in three previous fractures. The whole skeleton shows roentgenologic evidence of recalcification.

Case 10. Exactly the same sequence of events, the same coxa vara, and same recalcification occurred in another little girl, age 6 years, before and after removal of a compact hyperplastic parathyroid tumor. We have seen these peculiarities five times now in infantile types.

ARTHRITIC TYPES

Oppel brought forth the suggestion that multiple ankylosing arthritis may be of parathyroid origin, basing his observations on 70 parathyroidectomies he had performed for such arthritis. His reasoning for this is as follows: An infectious arthritis usually does not lead to ankylosis; but, if there is a hypercalcemia, deposits of calcium will take place around the infected articular and peri-articular tissues. Therefore, if such ankylosing polyarthritis shows parathyroid symptoms, a moderate increase of the serum calcium, hypotonia of the muscles, or other skeletal changes of decalcification, a parathyroidectomy is indicated. A warning here is in order. Parathyroidectomy is not a cure for

arthritis, but parathyroidism may accompany arthritic symptoms which may be the outstanding characteristic. Proper selection of such cases will prevent disappointment. In 41 cases of ankylosing polyarthritis, Oppel found the serum calcium at the upper limits of normal. His results from operation demand attention. Of 31 patients observed post-operatively for from seven months to two years, 16 were improved. This percentage is high, when we consider that Oppel always performed only a unilateral parathyroidectomy and that, in 11 cases, no parathyroid tissue was found.

A few cases of our own experience are as follows:

Case 11. Mr. A. H., 38 years old. The onset of his symptoms was in 1923, consisting of interphalangeal arthritis and arthritis of the left knee, accompanied by nervousness. X-ray examination revealed hypertrophic osteo-arthritis of the interphalangeal joints, knee joints, and spine. There was also decalcification of the spine. The blood calcium was 10 and the chronaxia was high. At operation on Sept. 14, 1931, an adenomatous thyroid and a parathyroid tumor, 1.5 cm. in diameter, were removed. Microscopy showed an island of parathyroid with new forming acini and fat, and cystic degeneration. Post-operatively the condition was markedly improved, and the joints became smaller. The blood calcium was 11.4, 9, 8.4. Improvement has now lasted for 14 months.

Case 12. Mrs. McA., 26 years old. In 1929, following pregnancy, the disease had its onset, with backaches and stiffness and a high dorsal kyphosis which resisted good orthopedic care. The joints were severely painful, so that insomnia resulted.

X-ray Examination.—Marked dorsal kyphosis with diminished intervertebral space, so that the anterior processes of the segments approached each other. The bodies of the sixth, seventh, and eighth vertebræ were narrowed.

The blood calcium was 10.4 and 11.5. There was evidence of pyelitis, with dysuria at times. On May 18, 1931, bilateral thyroid lobectomy was performed and two inferior parathyroids were removed. As a biologic test the parathyroids were transplanted to a case of tetany, with relief of tetany symptoms. The post-operative course was smooth, and there was immediate relief from pain, for the first time in two years. The improvement has continued for 18 months.

PAGET'S DISEASE

The identity of Paget's disease of the bone and osteitis fibrosa cystica (von Recklinghausen) has always been a point of dispute. Those who believe that they are two separate diseases cite differences in the microscopic structure and in the gross appearance of the bones; also the fact that Paget's disease in from 15 to 17 per cent of cases is followed by sarcoma. However, none of these differentiations is constant. They can be explained by the fact that Paget's disease occurs practically only after mid-life, and is a slower, more chronic form of parathyroidism. This also tells us why the changes in calcium metabolism, and so forth, are not so pronounced. We should bring the two under one heading because:

1. Quite a few cases have now been observed in which, in the same individual, some bones show the characteristics of Paget's disease and others of osteitis fibrosa cystica (5, 14).

2. Both types of symptoms improve after parathyroidectomy.

From our own observations we mention two cases of clear Paget's disease, improved by parathyroidectomy. If we are correct, there is certainly another marked therapeutic reason for classifying the two diseases as one.

Case 13, which showed marked thickening of the skull, fuzzy and ill-defined outline (resembling a negro's wool), and typical Paget's changes of the femur, showed marked general clinical improvement after operation and there was roentgen evidence of improvement in the bones

of the skull and legs. There was return of the muscular strength, with relief of pain.

Case 13. F. T., 53 years old. The onset of symptoms was from five to ten years before the present examination. The hat size increased from $7^1/_2$ to $8^1/_2$. Since 1918 there had been a loss of five inches in height. Other complaints were deafness, pain in the hand and the hips, and reduction of physical strength. The blood calcium was 11. X-ray examination showed typical changes of Paget's disease. On Nov. 11, 1931, parathyroidectomy was done. Microscopically the parathyroid was richly vascular. There was a smooth recovery with marked physical improvement and disappearance of pain.

Case 14. Mrs. S. U., 63 years old. This was a typical case of Paget's disease, with gross bony changes in the left femur. More or less deviation was noted on general roentgenographic check-up. The left femur was bowed, shortened, and painful, with roentgen evidence of Paget's disease. The blood calcium was 11.6 and 12.7. Thyro-parathyroidectomy, done on March 22, 1932, revealed an adenomatous thyroid and a parathyroid tumor. Biopsy was confirmatory of typical Paget's disease. Microscopically the parathyroid was compact and adenomatous.

The patient gained weight, and the pain disappeared. Roentgenographic check-up showed marked evidence of return of normal bone structure.

CONCLUSIONS

1. The true type of parathyroidism will not yield to medical care and should, therefore, be operated upon early to avoid crippling, or even a fatal outcome.

2. In the recognition of parathyroidism, the roentgenologist is, perhaps, the most important factor. Only in a very few exceptional cases will the roentgenogram be negative.

3. In cases of compression fracture of the spine, which cannot be explained by severe trauma or metastatic malignancy, a check-up of the whole skeleton, especially the skull and spine, will often lead to the diagnosis of parathyroidism. If the x-ray investigation is limited to the part complained of, the disease may be overlooked.

4. Parathyroidism is so frequent that it should be kept much more in mind than it has been heretofore. In doubtful cases, a general check-up of the skeleton by x-ray examinations, and also chemical tests for calcium and phosphorus and determination of the hypotonic condition of the muscles, will lead to more frequent recognition of the entity.

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THE PTOSED GALL BLADDER, A ROENTGENOLOGICAL STUDY[1]

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THE cholecystographic study in the routine roentgen visualization of the gall bladder is now recognized as a highly important and efficient method in the diagnosis of diseases of this organ. This procedure, in addition to contributing considerable information as to the pathologic changes, likewise lends itself admirably for physiologic and anatomic investigation. Previous to the period of the discovery of cholecystography there were no direct methods, aside from surgical, that could be satisfactorily utilized in studying the physiologic and anatomic variations of the vesicle. Since then, however, considerable impetus has been given to this subject and attention frequently has been directed to the signal importance of this procedure in the study of gall-bladder affections. It has been demonstrated, likewise, that the anatomical aspects can also be better determined by this method, inasmuch as it well presents in the living subject the exact position, size, shape, mobility, and contractility of the gall bladder as well as its relation to the adjacent organs.

Considerable literature has accumulated since this test was established, most of which relates to the diagnostic procedures. Recently, however, much information has been obtained regarding the physiology of the gall bladder as a result of this method of investigation. However, the cholecystographic anatomical research of this organ has been more or less neglected, and up to this time there has been but scant consideration given the subject, particularly from this standpoint. A large portion of the literature deals with the diagnostic reliability of the unfilled gall bladder, while the filled vesicle, being more difficult to evaluate, has not as yet been studied with the same degree of precision for possible evidence of early disease. The filled gall bladder, even though it may give a normal roentgenologic response to this test, may nevertheless in many instances harbor early pathologic changes. It has been shown that at least 15 per cent of the normally filled gall bladders reveal cholecystic infections. It is of interest, therefore, to study the filled gall bladder with meticulous care in order to further the diagnostic possibilities of this procedure.

In this study we especially desire to consider some of the roentgenologic anatomic aspects of the filled gall bladder. An attempt will be made to demonstrate some of its normal and abnormal phases and the relationship of the position of the gall bladder to the stomach and colon. For this study a group of 105 cases was investigated. The examinations were made sixteen hours after the gall bladder had been filled, following the oral administration of tetraiodophenolphthalein. The following findings were then considered: (1) Relation of the position of the gall bladder to the lower margin of the liver; (2) position, measured from a fixed point; (3) size; (4) shape; (5) contractility, and (6) relation to the position of the stomach and colon.

Position of the Gall Bladder with Relation to the Lower Margin of the Liver.—This was observed to be of paramount importance. Four distinct types were noted, as illustrated in Figure 1. In Type 1, the transverse gall bladder was found lying above the lower margin of the liver. Type 2 presents the vertical gall bladder with most of its shadow above the lower margin of the liver. Type 3 represents that form in which the gall bladder hangs below the liver, being either in the vertical or oblique

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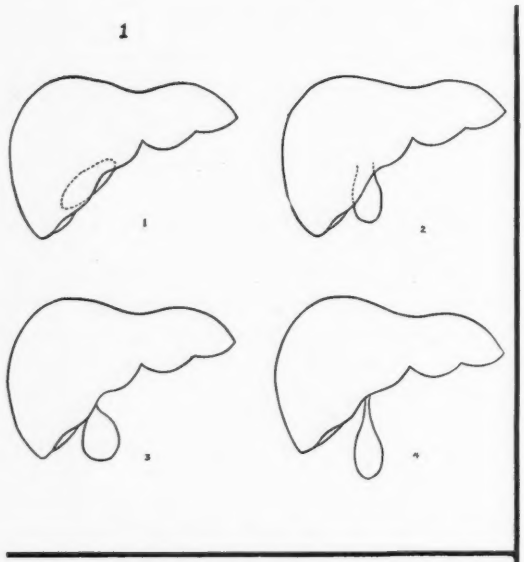


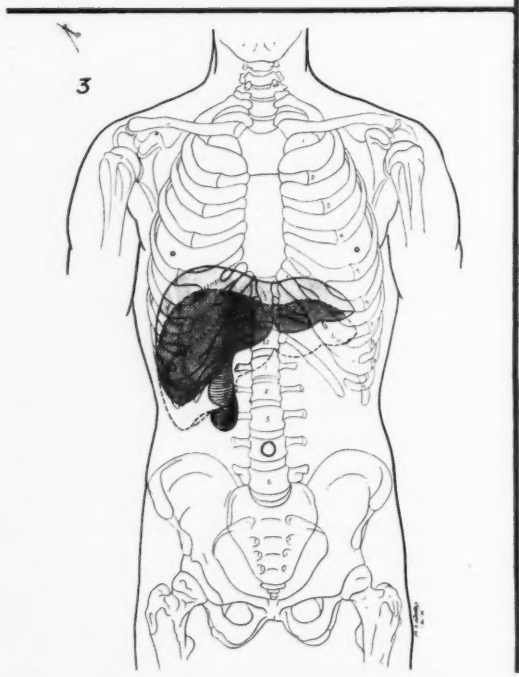
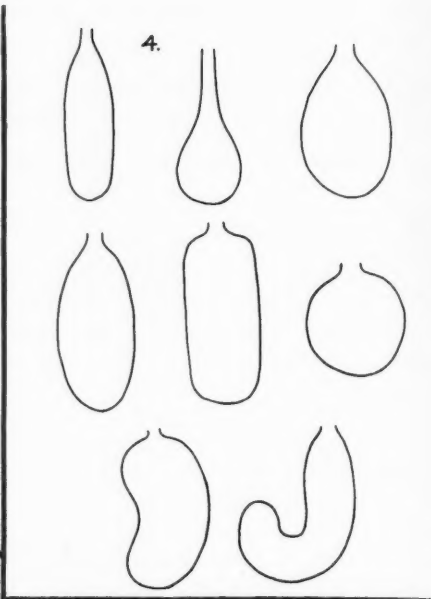


Fig. 1. Illustrates the four types of gall bladders according to relation to the lower margin of the liver.
Fig. 2. Shows the gall bladder in normal position and its relative position to the vertebræ.



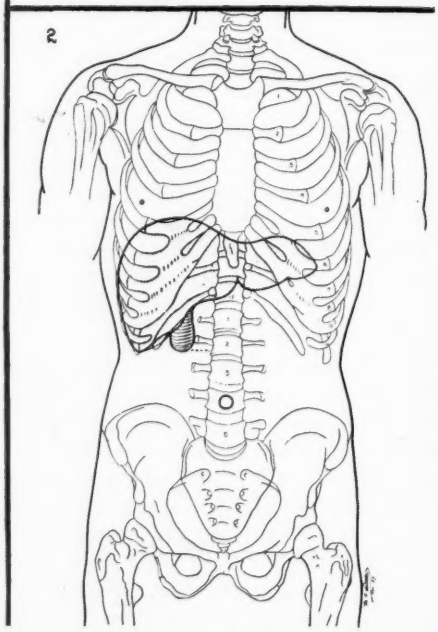


Fig. 3. Illustrates the mobility of the gall bladder, between the inspiratory and expiratory phases of respiration.
Fig. 4. Diagrammatic drawing of the various shapes of gall bladders.

position. Type 4 represents the pendulous gall bladder, usually of the vertical type and presenting itself below the liver margin.

In this series of 105 cases, the following types were observed: Type 1, 11 cases; Type 2, 39 cases; Type 3, 42 cases; Type 4, 13 cases. It thus becomes evident

from this study that in the majority, Types 2 and 3 predominate; together, these groups comprise 81 of the cases, while in Types 1 and 4 there were but 24.

Position.—The position of the gall bladder varies considerably in different individuals and may likewise vary in the same individual at different examinations. Little attention has hitherto been directed to the position of the gall bladder, though in my opinion this may be of importance and may in some instances be responsible for the production of symptoms referable to the organ—this is especially true as to the ptosed gall bladder. The position of the vesicle in this series was measured from an anatomical landmark, using the vertebra as a fixed point. The measurements were made from the tip of the fundus to the level of the transverse process of the vertebra. (See Fig. 2.)

In the 105 cases the following positions were encountered: Six were found to be on the level of the twelfth dorsal vertebra; 14 on the level of the first lumbar; 28 on the level of the second lumbar; 41 on the level of the third lumbar; 10 on the level of the fourth lumbar, and 6 on the level of the fifth lumbar vertebra. The examinations were made in the prone position and measured during the inspiratory phase of respiration. As a rule, the gall bladder occupies a position between the second and third lumbar vertebræ; it is possible, however, to find it in the pelvis. The location of the gall bladder should always be noted in the roentgenographic records, inasmuch as this finding may occasionally have some bearing upon the diagnosis, for the possibility of a ptosed gall bladder being responsible in some instances for the production of intermittent attacks of right upper quadrant symptoms should always be borne in mind. It is quite significant that in a not inconsiderable number of instances a ptosed vesicle may be the only objective sign pointing directly to a possible gall-bladder disturbance. On the other hand, it is by no means safe to state that the ptosed gall bladder is always pathologic, unless other abnormal signs co-exist.

Between attacks the ptosed gall bladder may fill well and function normally. On the contrary, notwithstanding this finding, it may show a distinct abnormal roentgenologic response during an attack. Such gall bladders, however, are most commonly diagnosed as normal, since examinations are usually performed in the interval between attacks. It is highly probable, however, that, under certain conditions, when the gall bladder is filled and distended, a dragging of the ptosed vesicle may produce a pressure or kink in the duct, which may in some instances even give rise to jaundice. It is quite possible too, under certain circumstances, for a markedly ptosed vesicle to become twisted, thereby producing a torsion of the cystic duct or of the gall bladder itself. This abnormal position must be considered, therefore, as a potential source of disturbance.

In the recurrent attacks in which abnormal pressure is made on the duct or when kinking occurs, a stagnation within the gall bladder may be produced which may favor the production of infection and consequently the formation of stones. In the persistently ptosed gall bladder in which the above changes have occurred over a long period of time, the vesicle may become dilated and more or less atonic. At this stage functional changes may occur. It is of interest to add that when the ptosed gall bladder functions well, the density of the shadow may even be greater than is usually observed in the normal vesicle.

In the atonic condition, the density of the gall-bladder shadow is frequently diminished. There is also a lessened degree of absorption and the filling is somewhat retarded. The emptying time is often slowed and in some instances may be markedly checked, so that little contraction occurs following a fatty meal. These changes occur as a result of a loss of tone or atrophy of the wall of the vesicle.

Of our 105 cases, 74 were found to be

normal from a cholecystographic standpoint and 31 abnormal. Of the 31 abnormal cases, 14 revealed evidences of cholecystitis without stones; 13 revealed stones, and in 4 pericholecystic adhesions were noted.

The positions of the normal gall bladders were compared with those of the abnormals and it was found that no definite relationship could be shown to exist as to the position of the gall bladder and the production of cholecystitis or stones.

In this series there were 16 presenting a low type of gall bladder, occupying a level between the fourth and fifth lumbar vertebræ. Of these, 13 may be classified in the group recognized as Type 4. These gall bladders hang low and are of the pendulous type. It is worthy of note that of the 16 cases in which the vesicle was situated low, there were only 4 (25 per cent) which presented definite pathologic cholecystographic changes.

While these findings are not entirely conclusive, they tend to indicate that the low type of gall bladder is not necessarily more prone to become diseased. Of the entire group, but slightly more than 30 per cent revealed pathologic gall-bladder changes. This series is without doubt rather small upon which to base definite conclusions, but it does clearly indicate that in general the position of the gall bladder bears but little definite relationship to the presence of disease of this organ. It must be remembered, however, that it does not appear justifiable to arrive at conclusions from the roentgenologic studies alone. Even in instances in which the gall bladder responds normally to the cholecystographic test, abnormal changes may be present. The rôle played by the ptosed gall bladder may be of importance, however, in some instances as bearing a direct etiologic relationship to the production of disease of this organ.

Stagnation and Stasis within the Gall Bladder.—Stagnation of bile in the vesicle may favor the production of infection or stones. A ptosed gall bladder may at times be responsible for stagnation, resulting in these changes, yet it is quite true that in the majority of instances no evidence of stagnation is encountered in this type of gall bladder. Stagnation resulting in poor emptying of the vesicle occurred in only three instances of the 16 low type gall bladders in the writer's series. These cases were examined during the period of quiescence, which may account for the small number with stasis. On the other hand, a ptosed vesicle may present definite evidence of stagnation, according to my observation, when the examination is made during an attack. It must be pointed out, however, that in some instances it may not be possible to visualize the vesicle during a gall-bladder attack, due to the transient obstruction of the cystic duct.

The Latent Gall Bladder.—As a result of ptosis of the vesicle a low grade infection may be produced, with few if any symptoms referable to this organ. The cholecystograms in this type may reveal findings within normal limits and no clue may be obtained to incriminate the gall bladder as a possible source of infection. This latent type occurs not infrequently and may account for certain cases of cholecystitis recognized at operation, notwithstanding the fact that from a roentgenological viewpoint they were considered normal.

Mobility of the Gall Bladder.—The mobility of the gall bladder is another interesting phase, revealing as it does the vesicle on different levels. This is of importance inasmuch as it is always desirable, when possible, to observe the shifting of the gall-bladder shadow, in order to separate it from that of the colon and also to note whether or not a suspected stone shadow or tumor defect changes its position with the vesicle. At times the shifting produces a more distinct and sharply defined shadow. It is well recognized that the liver and gall bladder move during respiration with the ascent and descent of the diaphragm. The position of the gall bladder was at first recorded with measurements made in inspiration and then again in expiration. (See Fig. 3.)

In this series of cases the following findings were observed as to the mobility of the gall bladder: In 11 instances this organ remained immobile; in the remaining the differences in the shifting varied from one-half of an inch to three inches. No relationship could be determined between the mobility of the normal and pathologic gall bladders.

Size of the Gall Bladder.—The size of the gall bladder visualized 16 hours after the oral administration of the dye varies considerably in the cholecystograms. The measurements were obtained during the inspiratory phase of respiration at a distance of 25 inches on the Bucky diaphragm. In the entire series the size ranged between 15 and 55 mm.: in the 74 normal cases the size varied between 23 and 45 mm., with an average of 32 mm.; in the pathologic cases, from 25 to 45 mm. in the gallstone cases, with an average of 34 mm., while in the cases of cholecystitis it ranged from 15 to 55 mm., averaging 37 millimeters.

The size of the gall bladder usually varies between the two phases of respiration: during expiration it was observed that normally its size was usually diminished and in many instances this variation in size was very marked.

Shape.—The shape of the gall-bladder shadow in this series presented no significant variation between the normal and abnormal, except in a few instances in which the gall bladder was found to be deformed and distorted as a result of adhesions or disease. The shape varies at times, depending upon the respiratory phase. The various shapes encountered in this series were as follows: tubular, oval, pendulum-like, banana-like, pill-like, circular, kidney-shaped, and hooked (Fig. 4).

Contractility of the Gall Bladder.—Following a fatty meal the gall bladder showed a normal contraction in 73 cases, poor contraction in 15, and no contraction in but 2. It emptied in 15 cases. These findings indicate that when the gall bladder actually fills, about 70 per cent of the cases contract normally.

Relation of the Position of the Gall Bladder to That of the Stomach and Colon.—In the study of the ptosed gall bladder it was of interest to demonstrate its relation to the adjacent organs. The low position of the gall bladder is usually associated with a ptosis of the stomach and colon. In the group of 105 cases, a gastro-intestinal examination was made in 70. Table I illustrates the comparative relation of the position of the gall bladder, stomach, and colon.

This comparative examination disclosed the fact that a definite relationship exists between the position of the gall bladder and that of the stomach and colon. As a rule, it may be stated that the higher the position of the gall bladder, the more apt is one to find the stomach and colon likewise high. On the contrary, when the gall bladder occupies a low position, a similar finding is usually observed with regard to the stomach or colon or both.

SUMMARY

A study of 105 consecutively filled gall bladders was made to determine the position of the organ, with special reference to the ptosed gall bladder and its significance.

In most clinics, the routine roentgen examination is usually made in the prone position and hence all the gall bladders in this series were measured from films made in the recumbent posture. However, we have fluoroscoped many of these, but no record was then made of the position. We[2] have stressed the importance of the fluoroscopic visualization of the gall bladder in the upright posture as an important procedure in the routine investigation of this organ. In order to further study its position, it would be well to further investigate the gall bladder in the upright posture, for it is quite evident that the reported number of low type gall bladders would greatly increase if this technic were routinely utilized.

In a consideration of the ptosed gall

[2] Theodore H. Morrison and Maurice Feldman, Ann. Clin. Med., October, 1926, IV, 330.

TABLE I

No. cases	Position of gall bladder	Position of stomach	Position of colon
2	12th dorsal vertebra	normal	normal
9	1st lumbar	normal	normal
19	2nd lumbar	16 normal 2 slightly ptosed 1 moderately ptosed	12 normal 3 moderately ptosed 4 markedly ptosed
28	3rd lumbar	20 normal 6 slightly ptosed 2 moderately ptosed	19 normal 2 slightly ptosed 6 moderately ptosed 1 markedly ptosed
7	4th lumbar	4 normal 2 slightly ptosed 1 maximum ptosed	2 normal 2 slightly ptosed 1 moderately ptosed 2 maximum ptosed
5	5th lumbar	0 normal 2 slightly ptosed 1 moderately ptosed 2 markedly ptosed	0 normal 3 moderately ptosed 1 markedly ptosed 1 maximum ptosed

bladder it is of interest to study the habitus of the patient, for it is well known that in visceroptotic individuals, all the gastro-intestinal organs are situated low and consequently a low position of the gall bladder may more commonly be found in this type.

One other point deserves mention, namely, the position of the liver. In not a single instance was the liver found to be ptosed. When the gall bladder hung low, with the other digestive organs, the liver remained in its normal position.

CONCLUSIONS

1. The ptosed gall bladder should be considered whenever a cholecystographic study is undertaken.

2. It is quite probable that this condition may be a factor, in some instances favoring the development of infection or stones.

3. There appears to be a definite relationship between the positions of the gall bladder and that of the stomach and colon.

4. The position of the gall bladder should always be recorded in the cholecystographic report.

5. The majority of gall bladders are found to be normally located on a level of between the second and third lumbar vertebræ.

6. In a study of gall bladders presenting lesions of various kinds, no relationship can be determined as to the diseased condition and that of the position or mobility of this organ.

7. The size of the gall bladder changes with respiration. It is found to be larger in inspiration and smaller in expiration.

8. The majority of filled gall bladders of the ptosed type will contract well, despite the fact that there may be a low-grade infection present.

9. Finally, the actual significance of this condition can be arrived at, by a more intensive study, correlating it with the associated clinical manifestations.

DISCUSSION

DR. LESTER LEVYN (Buffalo): Dr. Feldman is to be congratulated upon this excellent consideration of the ptosed gall bladder. The low gall bladder is encountered frequently and usually accompanies ptosis of the other viscera common to individuals of the hyposthenic habitus. I have not observed that disturbance of function occurs merely because the gall

bladder occupies a low position. The time of filling and emptying, as determined by cholecystography, is practically the same, regardless of the position of the gall bladder. If ptosis were conducive to stasis of bile, resulting in subsequent infection and stone formation, we would expect to find stones more frequently, whereas cholelithiasis is actually relatively uncommon in patients of this habitus.

Dr. Feldman called attention to the possibility of jaundice resulting from kinking of the ducts, due to ptosis. That is an interesting observation and certainly should be given our consideration in cases of undetermined jaundice occurring in ptotics.

ROENTGENOLOGIC OBSERVATIONS OF THE COLON IN AMEBIC DYSENTERY

WITH REPORT OF SEVEN CASES ORIGINATING IN CHICAGO[1]

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AN unusual opportunity was afforded the writer to record roentgenologic observations of the colon in amebic dysentery in a small series of patients who contracted the disease while visiting in Chicago during the Summer of 1933. A detailed account of nine of these cases has already been published elsewhere (1). The present communication will be confined to the discussion of the roentgenologic aspect of the changes found in the colon in seven patients, six from the same series, and one, a new case.

Unlike the cases reported in the literature, all of our cases furnished fairly accurate epidemiologic data and probably represented the uncomplicated stages of the disease with a lesion more or less localized and of comparatively short duration. Thus, it was possible to make an accurate correlation between the roentgen appearance of the specific lesion in the colon and the clinical stage of the disease.

The roentgenologic observation of the colon was undertaken both before and after the institution of emetine treatment in all but one of the seven cases. The examination was conducted primarily to elicit, if any, such changes in the colon as might be considered constant or characteristic in this disease during the particular stage of infection under our observation. At no time during the period of this study was the literature consulted. The observations, therefore, were original, independently made and recorded.

LOCAL PATHOLOGY OF AMEBIC DYSENTERY

In order to better appreciate the roentgen appearance of the colon in amebic dysentery, local pathologic anatomy may be briefly reviewed (2). It has been shown that the cysts of *Endameba histolytica* are carried down into the cecum before they become activated into the protozoan form. The normal alkaline reaction of the flora of the colon and the natural reservoir-like behavior of the cecum appear to favor the multiplication of the liberated amebas and the development of the first lesions in this portion of the colon. It is likely that the majority of the cases diagnosed and treated early may escape without further involvement than the cecum and the proximal portion of the ascending colon. The rectum, another dilated reservoir, is known to be the second common site of involvement, followed by the adjacent sigmoid. Clark (3), investigating the distribution of amebic lesions in 186 postmortem examinations, found the cecum to be involved in 88.7 per cent of the bodies, the ascending portion in 78 per cent, the rectum in 72.5 per cent, the sigmoid in 71.5 per cent, the splenic flexure in 63.4 per cent, the transverse portion in 61.2 per cent, the hepatic flexure in 60.7 per cent, and the appendix in 40.8 per cent. Of the 63 cases (33.8 per cent) which revealed the ulcers in certain regions only, 87.3 per cent were found in the cecum and 57.1 per cent in the ascending colon, 39.6 per cent in the rectum, 33.3 per cent in the sigmoid, 33.3 per cent in the appendix, 12.6 per cent in the splenic flexure, 6.3 per cent in the transverse colon, and 4.7 per cent each in the hepatic flexure and in the descending colon. The early lesions are essentially microscopic or quite superficial. The amebas penetrate the mucosa along the glandular slits and invade deeply into the submucosa, where they multiply and, by their cytolytic action, cause a rapid liquefaction necrosis

[1] Presented before the Minnesota Radiological Society, March 10, 1934. Submitted for publication.

of the involved area. This is soon transformed into a cyst-like formation which become filled with glairy mucus and bulges out over the mucosal surface. At the point of primary invasion, a small superficial ulcer with a necrotic center develops. This communicates with the underlying submucosal area of necrosis. A well-developed lesion is characterized by a deep, irregular ulcer involving the submucosa and often penetrating into the circular bundles of the muscle layer, with an overhanging and undermining mucosal edge, a necrotic base, and an edema and induration of the surrounding tissues. There is also a tendency to establish submucosal inter-communications or tunnels between the ulcers. Two or more of these ulcers may thus become coalesced, leaving the overhanging bridges of a comparatively healthy mucosa which separate the primary ulcers. There are the usual inflammatory reactions of varying intensity involving the tissues all around the ulcers. Areas of repair and cicatrization and of fresh involvement are constantly added to the general pathologic picture. All these processes cause irregular induration and thickening of the wall and a consequent deformity and narrowing of the lumen. Doubtless, there develops functional disturbance in the muscular action of the wall, by reason of the unequal distribution of the lesions and of, what is probably more important, the changes in the biochemical reaction of the tissues, brought about by the metabolic products of the amebas, all of which add to the anatomic changes in the gut.

During the earlier stages of amebic dysentery, these lesions may be comparatively free of secondary infection, unless a co-existing bacillary dysentery complicates them from the beginning. In the presence of a secondary or co-existing infection, the gross appearance of the lesion may become more or less modified until, in extreme instances, the characteristic amebic ulcers of the colon may be entirely obscured.

Amebic lesions of long standing may develop into a granulomatous growth, involving either a large segment of the colon diffusely or a single localized area, as a tumor (4). Two or more localized growths have also been observed, or both localized and diffuse lesions may co-exist in the same colon. A localized granulomatous lesion may cause an obstructive symptom and is easily mistaken for a cancerous growth, clinically and roentgenologically. In the diffuse type, the involvement is usually too extensive or the lesion too atypical in distribution and appearance to be either tuberculous or carcinomatous. Without the demonstration of *Endameba histolytica* in the stools or in the lesion, the condition may remain undiagnosed. Without the proper histologic examination, the anatomic lesions may resemble, grossly, cancer, tuberculosis, syphilis, or other granulomatous growths and may remain so diagnosed by the examiner.

The terminal ileum may become involved early. The ileocecal ring becomes stretched, due to the extension of the inflammation, and allows constant regurgitations of the fecal contents into the terminal ileum. This causes not only a mass migration of the amebas from the cecum into the ileum but also alkalinization of the fecal flora which favors their continued existence. The development of a primary amebic lesion in the small intestine is a disputed question. There seems to be no fundamental objection against believing that such a lesion may occur under certain unusual conditions.

REPORT OF CASES

The cases are divided into the acute, the sub-acute or recurrent acute, and the early chronic forms, depending upon the duration of illness in each instance. All of them were suffering from active dysentery and abdominal discomfort of varying intensity at the time of admission to the hospital. The diagnosis of amebic dysentery was readily established through the identification of *Endameba histolytica* in the stools.

Of the total of seven cases, two were in the acute stage, four in the sub-acute or

recurrent acute stage, and one in the early chronic stage. The clinical histories in these cases, with the exception of Case 3, will be found in detail in the published article to which reference has already been made (1).

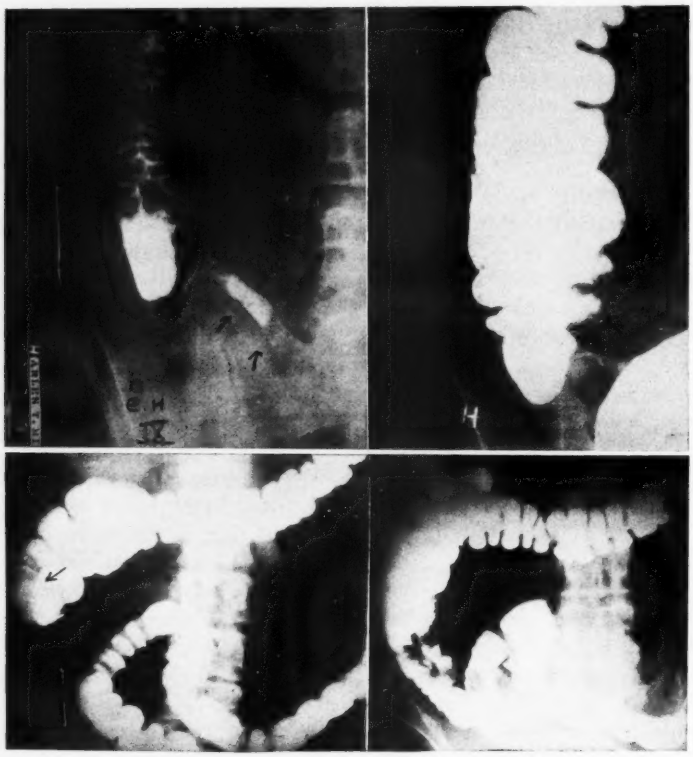

Fig. 1-*A* (*above*). Case 2. The cecum and ascending colon, immediately following evacuation of a barium enema, on the seventh day of illness. Note the residue in the cecum. The appendix is long and its distal half irregularly dilated.

Fig. 1-*B* (*above*). Case 2. The cecum and ascending colon about seventy-five days after the treatment began. Note a small filling defect along the medial aspect of the cecum near the base of the appendix, which is no longer dilated as in Figure 1-*A*.

Fig. 2-*A* (*below*). Case 3. Shortening of the ascending colon and a slight irregularity and induration of the cecum.

Fig. 2-*B* (*below*). Case 3. The same colon twelve days later, after a course of treatment.

ACUTE FORM

Case 1, R. P., a school girl, aged 8; admission, Nov. 13, 1933; duration of present illness, a few hours; probable incubation period, 56 to 58 days. The diagnosis was made on the first day. Symptoms: severe abdominal cramps as of an acute surgical condition.

Roentgen examination of the colon on the second day of illness (Nov. 14), and again on March 24, 1934, was negative.

Case 2, E. H., female, aged 38; admission, Nov. 30, 1933; duration of the present illness at the time of admission, six days; probable incubation period, 74 to 77 days. The diagnosis was made on the sixth day of illness. Symptoms: mild diarrhea, with fresh blood in stools; no other complaints.

First roentgen examination of the colon, on the seventh day of illness (Nov. 31), was essentially negative except for slight spasm of the ascending colon and for a long appendix, showing a marked dilatation of its distal half, with an irregular filling of the lumen, suggesting a diffuse ulcerative lesion of the mucosa. No tenderness over the appendix or cecum (Fig. 1-*A*).

The second roentgen examination (Feb. 15), was made about 75 days after the beginning of treatment, while the patient was entirely symptom-free and the stools were repeatedly negative. There was no spasm in the colon, but a small area of filling defect along the medial aspect of the cecum over which there was definite tenderness. The roentgenograms (Fig. 1-*B*) showed fine feathery or thorny irregularity along a coarse defect, probably representing a localized granulomatous thickening of the wall.

SUB-ACUTE OR RECURRENT ACUTE FORM

Case 3, C. M., male, aged 67; admission, Jan. 17, 1934; probable duration of the present illness, at the time of admission, 30 days; probable incubation period, about two months. The diagnosis was made on the thirtieth day of illness. Symptoms: a period of obstipation followed by intermittent diarrhea and cramps; a violent attack of dysentery, with frequent explosive watery movements for two days before admission; vague tenderness over McBurney's point.

First roentgen examination of the colon on the thirty-first day of illness (Jan. 18).—There was no spasm. The cecum and the ascending colon were shortened and "lifted-up" under the costal margin. There was localized rigidity of the wall, with irregularity of the outline at the distal end of the cecum (Fig. 2-*A*). Definite tenderness over this area.

Second roentgen examination (Jan. 30), twelve days after the institution of emetine treatment.—The cecum and ascending colon were seen to be smooth and flexible in outline and had resumed the normal relative position (Fig. 2-*B*).

Case 4, T. P. A., male, aged 52; admission, Oct. 19, 1933; probable duration of the present illness, at the time of admission, 92 days; probable incubation period, 24–26 days. The diagnosis was made on the ninety-second day of illness. Symptoms: Recurrent attacks of abdominal discomfort and diarrhea and a "run-down" condition since the middle of July, together with an acute attack of diffuse abdominal tenderness and enlargement of the liver, with the temperature of 103° when admitted. No roentgen examination of the colon was possible at this time.

First roentgen examination of the colon on the day of discharge from the hospital (Nov. 5), sixteen days after the beginning of treatment.—The colon was diffusely dilated; the cecum showed a slight deformity but was not spastic or indurated; there was no local tenderness. The clinical improvement of the patient was slow.

The stools showed many cysts and occasional motile amebas at various times.

Second roentgen examination, March 5, 1934, four and a half months after the institution of the first emetine treatment.—There was a slight deformity, with rigidity of the wall, along the medial aspect of the cecum which was quite tender on palpation. Deep spastic contractures developed, slowly involving the cecum and ascending colon (Figs. 3-*A* and 3-*B*).

Case 5. H. C., male, aged 51; admission, Oct. 12, 1933, for a biopsy of a growth from the rectum which was negative for malignancy. Second admission, Oct. 30, was for a second biopsy. The probable duration of the present illness, at the time of the second admission, was 75 days; the probable incubation period, 53–57 days. Symptoms: Recurrent attacks of abdominal cramps and diarrhea since Aug. 15, 1933; marked rectal pain and tenesmus, for which a physician was consulted on Sept. 10.

First roentgen examination of the colon, Sept. 10, or about twenty-five days after the onset of illness, was reported negative (Fig. 4-*A*).

The diagnosis of amebic dysentery was

not made until Nov. 8, when the first specimen of stool was submitted for examination. Serial sections of the biopsied specimen from the rectum also showed nests of amebas.

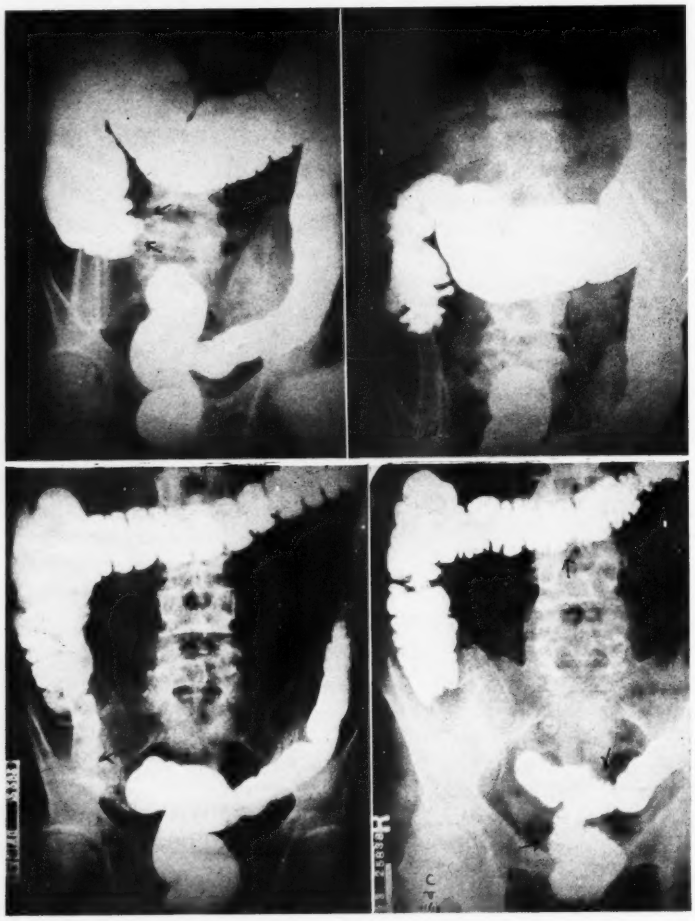

Fig. 3-*A* (*above*). Case 4. The colon about four and a half months after the patient's discharge from the hospital, showing an area of induration and a filling defect along the cecum, medially. There was definite tenderness over this area.

Fig. 3-*B* (*above*). Case 4. The cecum and ascending colon, a few minutes later, showing deep spastic contractions.

Fig. 4-*A* (*below*). Case 5. The colon twenty-five days after the onset of illness, reported negative. Note the slight contractural deformity of the cecum and ascending colon, with loops of the terminal ileum prominently displaced along the ascending colon.

Fig. 4-*B* (*below*). Case 5. The same colon, ten days after the institution of the treatment and about two months after the first roentgenogram was taken. Note the saw-tooth irregularity in the transverse colon and the shaggy, feathery defect of the rectum and sigmoid.

Second roentgen examination, Nov. 16, eight days after the institution of treatment, while the stools still showed occasional cysts and motile amebas.—There was a slight deformity of the cecum and ascending colon, small areas of fine saw-tooth irregularity along the transverse

colon and coarse, feathery or shaggy filling defects along the rectum and sigmoid which were absent in the first roentgenograms (Sept. 10). This indicated not only the development of fresh superficial ulcerative lesions in the transverse colon but the persistence of the granulomatous lesions of the rectum, in spite of the course of emetine treatment, just completed (Fig. 4-*B*).

Third roentgen examination, Feb. 6, three months after the institution of emetine treatment.—For the first time, there was a high degree of spasticity in the cecum and ascending colon, in marked contrast to the behavior of the same area during the previous fluoroscopy. There were, however, no demonstrable lesions either here or elsewhere in the colon, which had resumed its normal contour (Fig. 7-*A*).

Case 6. C. B., male, aged 59; admission, Oct. 13, 1933, for a rectal biopsy, which was negative for malignancy; probable duration of the present illness, 45 days; probable incubation period, 7–15 days. The diagnosis was made on the forty-fifth day of illness. Symptoms: Rectal pain and tenesmus; recurrent abdominal cramps and diarrhea, with blood; a boggy palpable mass, with tenderness on palpation, in the right lower quadrant.

First roentgen examination of the colon (Oct. 13), 44 days after the onset of illness.—There was no demonstrable spasm of the colon. There was an extensive filling defect involving the cecum and ascending colon, which appeared somewhat shortened and contracted. There was palpable induration or infiltration in the wall, with an irregular narrowing of the lumen (Fig. 5-*A*). There was retention of the barium in the lumen of the involved portion of the colon after the evacuation of the enema. The shadow was interpreted as being due either to a chronic non-tuberculous inflammatory or granulomatous ulceration or an infiltrating growth such as leukemia or Hodgkin's disease. Carcinoma was thought unlikely because of the extent of involvement and the apparent good health of the patient. Tuberculosis was not considered because of the absence of spasm. Noted also was the patency of the ileocecal ring, indicating its involvement in the diffuse process. The appearance of the terminal ileum suggested induration of the wall due to the extension of the lesion. The stools had not been examined on this day and the patient was discharged.

The second admission was on Oct. 18, with a diagnosis of amebic dysentery. A course of emetine treatment was given for ten days, after which there was a marked clinical improvement and rapid disappearance of the mass in the right lower quadrant.

Second roentgen examination, Dec. 11, about two months after the beginning of emetine treatment.—The colon was reported to be normal. The roentgenograms (Fig. 5-*B*) showed the cecum and ascending colon to have resumed their normal length and diameter and their smooth outline and flexibility.

EARLY CHRONIC FORM

Case 7. M. M., female, aged 53; admission, Nov. 21, 1933; probable duration of the present illness, at the time of admission, 125 days; probable incubation period, 9–14 days. The diagnosis was made on the one hundred and twenty-fifth day of illness. Symptoms: Weakness, vague abdominal distress, and diarrhea, with a slight elevation of temperature (present since July, 1933), and periodic exacerbation of the symptoms.

First roentgen examination of the colon (Nov. 24), about one hundred and twenty-eight days after the onset of illness.—There was an irregular narrowing of the lumen, with induration of the wall and obliteration of the haustral markings throughout the transverse colon and an identical deformity and shortening of the cecum and ascending colon, with fine irregularity of outline along the involved wall. There was also a rigidity of the terminal ileum. There was no spasm in the colon (Fig. 6-*A*).

Second roentgen examination, Dec. 8,

14 days after the institution of Stovarsol and emetine treatment.—The colon was not spastic, its wall was soft and flexible, its outline smooth, and the haustration well defined. There was a small area of induration along the lateral aspect of the cecum which might represent a residual active lesion (Fig. 6-*B*). A clinical improvement in the condition of the patient was equally remarkable during this period.

Third roentgen examination (March 10), about three and a half months after the beginning of treatment.—The colon poorly tolerated the clysma and showed a marked degree of spasticity, especially in the cecum and ascending parts. Small, spastic waves were also noted along the transverse colon. There were no demonstrable filling defects, but the behavior of the colon strongly suggested a re-activation of the old amebic colitis (Fig. 7-*B*).

SUMMARY OF ROENTGEN FINDINGS

The roentgen appearance of the colon during the earlier stage of amebic dysentery was negative except for mild spasm. The duration of the incubation period had no bearing upon the roentgen findings. The patients (Cases 6 and 7) with the shortest incubation period (7–15 days and 9–14 days) showed the most marked involvement of the colon. An abnormal filling of the appendix was noted in Case 2, within a week of the onset, probably due to a primary amebic ulceration in this organ.

The fine, saw-tooth filling defects along the transverse colon in Case 5 might easily be due to early ulcerative lesions. The minute, shaggy irregularity of the outline along the rectum and sigmoid in the same case and the delicate feathery or thorny filling defects along the cecum in Case 2, in her later examination, probably represented a granulomatous, ulcerative lesion due to the infestation of *Endameba histolytica*.

During the sub-acute or early chronic stage of the disease, with active dysentery, the roentgen appearance of the colon was more definite. Fluoroscopically, the barium clysma was tolerated without discomfort in every instance. No appreciable spasticity of the bowel was noted, a striking observation in view of the extent of the involvement. The involved area, usually the cecum and ascending colon, lacked the usual flexibility of the wall, which was now somewhat resistant and apparently indurated, under the palpating hands, as in Case 6. There was a shortening and upward displacement of the cecum, with demonstrable local deformity or filling defects. Local tenderness on palpation was not constant in every case. Spastic contractions and deformities were conspicuous by their absence.

By the extension of a like process into the transverse colon, the roentgen appearance of the colon in Case 7 became somewhat confusing with that of a chronic nonspecific ulcerative colitis. The latter, however, frequently involves the descending colon, which is seldom affected by amebic infection.

As a rule, varying amounts of barium residue were noted in the cecum after the evacuation of the enema, during the stage of active dysentery, indicating the absence of spasm in the involved portion. Frequently observed, also, was wide patency of the ileocecal ring, allowing constant flow of the clysma into the terminal ileum, which was apparently invaded by the infection.

A difference in the roentgen appearance of the colon before the institution, and after the completion, of a course of emetine treatment, was strikingly demonstrated in several of the cases. The colon resumed its normal contour and position within as short a period as two weeks, as in Cases 3 and 7. The flexibility of the wall returned, the outline became smooth, the haustral markings were more distinct, while the filling defects and the general deformity of the involved area were no longer present.

A well-localized lesion in the cecum which apparently had developed during a symptom-free period of several months (in which medication had been continued

and the stools were free of motile amebas on repeated examinations) was unexpectedly demonstrated roentgenologically in Cases 2 and 4.

The type of amebic lesion in the colon, revealed roentgenologically, may differ in individual cases. The outstanding examples were found in Cases 6 and 7. In the former, a granuloma-like behavior of the lesion in the cecum and ascending colon was evident, while in the latter, though of a longer duration, a chronic ulcerative feature was predominant. A response to emetine therapy was equally

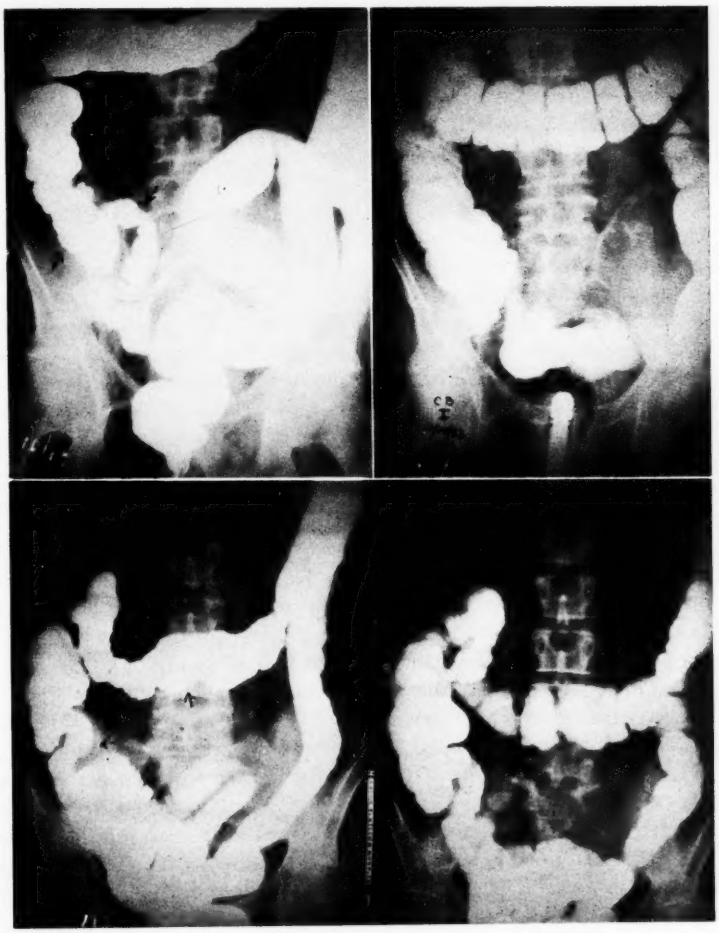

Fig. 5-*A* (*above*). Case 6. Irregular narrowing and filling defect in the cecum and ascending colon on the forty-fourth day of illness. Note the patent ileocecal opening and the filled terminal ileum.

Fig. 5-*B* (*above*). Case 6. The same colon, two months after the treatment was started. Compare the appearance of the cecum and ascending colon with that in Figure 5-*A*.

Fig. 6-*A* (*below*). Case 7. A marked involvement of the cecum, ascending colon and transverse colon, on the one hundred and twenty-eighth day of illness. Note the shortening and deformity of the ascending colon with a widely patent ileocecal valve and the dilated and apparently indurated terminal ileum.

Fig. 6-*B* (*below*). Case 7. The same colon after fourteen days of treatment. Note the remarkable improvement in the appearance of the colon.

prompt and effective in either type of lesion.

The absence of spasm in the involved portions of the colon and the apparent shortening or shrinking of the cecum and ascending colon during the active stage of the disease were the observations of importance which demand explanation. The demonstration, for the first time, of marked irritability and spasticity in the same areas, now apparently healed, in Cases 4, 5, and 7, after a comparatively symptom-free period of four and a half months, three months, and three and a half months, respectively, was another observation which was difficult to appreciate. The explanation of these peculiar behaviors probably lies in the realm of pathologic physiology and chemistry of the tissues, particularly the muscle, occasioned by the metabolic activity of *Endameba histolytica*.

REVIEW OF LITERATURE

Few references are available on the roentgen observations of intestinal amebiasis. Vallarino (5) found filling defects along the wall of the colon in all cases of amebic infection with definite symptomatology, whether mild or severe. These defects were present at the points of tenderness in the abdomen. He was able to determine the extent of involvement and found a valuable guide in the course of treatment. Occasionally, he found the lesion to be more extensive than the clinical symptoms indicated. As to the types of the defects, he mentioned "a mottling of the affected part," "loss of the normal contour of the bowel," and "in old cases, defects resembling obstructions." The most frequently involved portions according to this author were, first, the cecum and ascending colon, and, next, the sigmoid. Vallarino, in his first published article on this disease (5), expressed his preference for a barium meal by mouth, in the examination of the colon, over the direct injection of a barium enema. He appreciated the value of re-examination of the colon while under treatment, to determine the extent of improvement in the lesions, as compared with the clinical improvement.

Henderson (6) observed few or no manifestations of spasm in the colon, in spite of the presence of numerous lesions, and he considered this finding to be of major importance in contrast to "the irritable cecum of tuberculosis and other ulcerative lesions." Henderson noted the bowel wall to be serrated with fine, saw-tooth or rose-thorn projections, suggesting the fringed gentian, and stated that "it is common to observe upon the plate the actual tunnel which is joining the base of two or more ulcers."

Both Vallarino and Henderson were dealing with chronic cases of unknown duration, and both considered the roentgen findings suggestive but not pathognomonic. Henderson, however, claimed that, in over 97 per cent of the patients exhibiting these roentgen findings, he was able to demonstrate *Endameba histolytica* in the stools, and that more than 60 per cent of these patients had shown no symptoms pointing in the direction of amebiasis.

Gunn and Howard (4), discussing the clinical resemblance to carcinoma of amebic granuloma of the large bowel, observed that the x-ray filling defects were produced by amebic thickening of the bowel, but felt that this usually involved such an extensive area of the intestine that the question of carcinoma did not arise. "However, occasionally such masses are localized and may readily cause confusion in diagnosis" and "not infrequently, the thickened bowel may be palpable through the abdominal wall. These conditions are usually encountered in cases of chronic amebiasis of long standing." The authors cited three patients in whom operative removal of an obstructing mass in the colon was done. The removed mass, in each instance, represented a large, hard, localized tumor of the colon, with central ulceration. In the first case, because of the extent of involvement as revealed on the roentgenograms and the fact that *Endameba histolytica* was demonstrated in the stools, a chronic amebic granuloma was

suspected rather than malignancy, while in the two remaining cases, a diagnosis of carcinoma of the cecum seemed justified because of the palpable mass in the right lower quadrant, with all other clinical signs of malignancy to support it. No roentgen findings in these two cases were recorded. However, the filling defects in the colon produced by any one of these three masses might well have been interpreted roentgenologically as carcinoma.

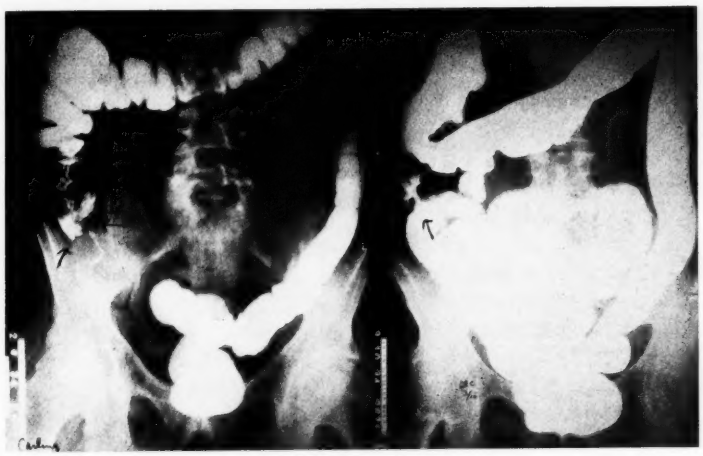

Fig. 7-*A*. Case 5. The colon three months after the institution of the first course of treatment. Note the marked spasm of the cecum and ascending colon.
Fig. 7-*B*. Case 7. The colon three and a half months later. Note the marked spasm of the cecum and ascending colon.

Harrison (7) reported such a patient, a native of Michigan, on whom was made a clinical diagnosis of carcinoma of the cecum, supported by the roentgen finding, interpreted as a cancer involving the hepatic flexure. The resection of the mass was impossible at operation due to the extent of involvement, but the thickened and indurated appendix was removed. *Endameba histolytica* was demonstrated in the appendix and was found in the stools, post-operatively. Whether or not a carcinomatous growth was the basis of the mass and the filling defect at the hepatic flexure, was not revealed. A co-existence of amebic dysentery and carcinoma must still be borne in mind.

Such a confusion was recently experienced by a roentgenologist who made an x-ray diagnosis of carcinoma of the colon in an emaciated patient, with an enlarged nodular liver. The patient was a Spanish-American War veteran who, besides, gave a history of a Chicago visit in the Summer of 1933. He had had a previous roentgen diagnosis of probable amebic granuloma of the sigmoid, with obstruction, on the basis of the demonstration of *Endameba histolytica* in the material obtained from the lesion. The roentgenograms showed the typical deformity of an advanced cancer of the sigmoid. There was no clinical improvement under emetine therapy. Autopsy (12) revealed an ulcerating, annular carcinoma of the sigmoid, with massive metastasis to the liver, and also a small, solitary, early amebic ulcer about one centimeter in diameter, near the splenic flexure.

In case the involvement is found to be more diffuse, although the filling defects may be most marked in areas and the obstructive symptoms may develop as a result of localized narrowing of the lumen, a diagnosis of carcinoma is not likely to

be considered, roentgenologically. This is well illustrated by the first of the three cases reported by Gunn and Howard, already cited, as well as cases reported or cited by Desjardins (8), Vallarino (5) and others (9, 10, 11).

SUMMARY AND CONCLUSIONS

1. The roentgen appearance of the colon in amebic dysentery may vary considerably depending upon the stage of infection, the extent and degree of involvement, and the type of the lesion produced.

2. On the whole, no appreciable changes are probably noted roentgenologically in the early stage of infection. Later, fine, saw-tooth projections may develop along the wall, which probably represent small superficial ulcers and which may soon become obliterated by inflammatory edema and exudation. Fine feathery or thorny filling defects on the indurated wall probably signify a later stage of the same lesion in which the submucosa and muscularis are involved in an extensive inflammatory granulation process.

3. A somewhat characteristic deformity of the cecum and ascending colon is observed, roentgenologically, during the subacute or early chronic stage of the disease when there may be an apparent shortening or contraction of the wall, with induration and filling defects in varying degrees. These changes are rapidly eradicated by the institution of emetine treatment.

4. An advanced amebic lesion, when diffuse and extensive, is not likely to be confused with cancer. When localized and obstructive, it may be mistaken for cancer, from which there is no roentgenologic means of differentiation.

5. The roentgen appearance of the colon in amebic dysentery may be presumptive or suggestive of the disease but not positive or diagnostic, without collaborating clinical and laboratory evidences. On the whole, however, it does not resemble the usual picture of non-specific ulcerative or tuberculous colitis, nor does it, as a rule, simulate the typical appearance of a cancer of the colon.

6. The roentgen examination of the colon is a positive means of determining the location, extent, and degree of involvement in amebic dysentery and of observing the progress of the disease under specific treatment, from time to time. A small area of fresh involvement or the re-activation of old lesions may thus be demonstrated, roentgenologically, during a period of continued clinical improvement and negative or inconstant routine laboratory evidence. Thus, the roentgen examination of the colon may prove superior and more accurate than other means of demonstrating the presence of active lesions in the treated or proven cases of intestinal amebiasis. The value of the roentgen examination of the colon in this disease, therefore, lies more in its use as a guide in the general management of the patient than as a means of positive diagnosis.

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VISCERO-CARDIAC REFLEXES[1]

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IN his book, "Facts on the Heart," Cabot writes: "The first and in some ways the most important point of all to remember is to know that most "heart disease" is imaginary. Those who think or fear that they have heart disease usually turn out, on careful examination, to be free from it. Whether or not this pseudo-heart disease, this groundless fear of heart disease is as common as I believe it to be, it is certainly common enough to make the thought of it an essential part of our mental furniture whenever we begin the examination of a supposedly cardio-vascular case. For the needless sufferings and sacrifices of such patients are very great. To my knowledge boys have given up their chosen life work, girls their prospect of marriage, business men their favorite projects, because of a false diagnosis of heart disease. The fears, disappointments, and ailments resulting from such a diagnosis may be enough to render a person's life miserable. And all this one can sweep away by a clear and positive reassurance based on a thorough examination. I know few greater services that a physician can perform, few that give him livelier satisfaction." Cabot's words might be appropriately paraphrased to read: There are "few greater services that a roentgenologist can perform, that will give him livelier satisfaction," for often a definite diagnosis is possible only by means of a roentgen examination which may disclose unsuspected lesions remote from the source of the symptomatology.

The increase in the incidence of heart disease is causing much distress among the laity and many apprehensive individuals are consulting their physicians with complaints which are purely functional cardiac disturbances due to lesions and derangements of the abdominal viscera as well as from other sources. In this era of "heart-consciousness" we are prone to overlook the fact that cardiac symptoms are not necessarily the result of cardiac disease *per se*.

Sir Henry Head early directed attention to the fact that pain in the left chest, particularly in the region of the heart apex, is often of cutaneous origin, due to a hyperesthetic segment of the cord caused by visceral stimulation of this segment. Weiss and Davis, in 1928, studying visceral pain, concluded that afferent cutaneous impulses bear a close relationship to the mechanism of visceral pain. They were able to abolish visceral pain completely by novocain anesthesia of the related skin segments and found that patients suffering from distinctly localized severe visceral pain were given prompt relief by infiltration of the corresponding skin area with novocain.

Experiments on animals have shown that when certain nerve pathways are severed it is impossible to induce premature contractions of the heart.

Schrager and Ivy have demonstrated reflex inhibition of the diaphragm, as a result of distention of the gall ducts, and have studied the pathway (right splanchnic and vagus).

Straus and Hamburger have shown that visceral disease may produce cardiac irregularities reflexly and have demonstrated that repair of the diseased viscus abolishes the irregularities. Babcock, likewise, has observed the effect of visceral disease on the production of cardiac irregularities and has discussed these observations at length. Rothburger produced extra systoles by stimulation of the vagus and sympathetic, after poisoning the heart muscle with barium chloride, and Levy has done likewise with chloroform. Recently Crittenden and Ivy have demonstrated experimentally that nausea, retching, and

[1] Read before the American Congress of Radiology, at Chicago, Sept. 25–30, 1933.

vomiting may cause in normal unanesthetized dogs cardiac irregularities such as heart blocks, cardiac arrests, ventricular and auricular ectopic beats. Pre-existing icterus increases the incidence of the irregularities, because icterus sensitizes the cardiac vagal mechanism.

The results of experiments designed to increase the irritability of the cardiac mechanism concerned in the production of arhythmias by visceral excitation have corroborated clinical observations.

Some of the causes of referred symptoms to the precordium are: Biliary tract disease, peptic ulcer, cardiospasm, mediastinal tumors, cervical rib, hyperthyroidism, herpes zoster, aërophagia, causing distention of the stomach and the colon, especially the splenic flexure.

Pardee recently called attention to osteoarthritis of the dorsal vertebræ, with resultant irritation of the dorsal nerve roots, as a cause of precordial pain.

Barnes, in a late issue of the "Proceedings of the Staff Meetings of the Mayo Clinic," reported a case in which a diagnosis of heart disease had been made by the home physician and the patient advised to stop work. At the Clinic a tentative diagnosis of angina pectoris was made. Part of the history was against such a diagnosis and a fluoroscopic examination of the stomach, requested by Dr. H. L. Smith, revealed a diaphragmatic hernia. The fact that the anginal pain occurred while at rest and was not induced by effort prompted x-ray examination of the stomach and a correct diagnosis resulted.

It is a common clinical experience to encounter patients with biliary tract disease, particularly cholelithiasis, subject, especially during attacks, to cardiac irregularities, the most frequent type being premature ventricular contractions. The following cases are briefly illustrative:

Case 1. M. G., a physician, 40 years old, suffered frequent attacks of upper right quadrant pain and during the attacks was conscious of premature contractions which he was well qualified to interpret. The frequency of the contractions was greatly intensified when jaundice occurred. Roentgen examination revealed the presence of gallstones. After cholecystectomy in 1917 the irregularities were entirely abolished and have remained in abeyance since.

Case 2. E. G., a hospital orderly, 36 years of age, for two years had complained of frequent attacks of cardiac palpitation and a dull pain over the precordium. The attacks were of short duration and usually occurred during the night. The patient attributed his symptoms to the physical exertion occasioned by the nature of his duties and did not seek medical attention until he became jaundiced. The jaundice was first noted on arising on March 25, 1933. Other than this, there were no symptoms referable to the hepatobiliary or gastro-intestinal tracts. Roentgenograms of the heart and electrocardiographs, together with physical examination, disclosed no heart disease. A flat film of the gall bladder showed no visible stones. Cholecystography, however, revealed the presence of a persistent negative shadow which was diagnosed as a gallstone. At operation on April 4, 1933, a single small stone was found in the gall bladder and another in the common duct. Since cholecystectomy was performed there has been no recurrence of the palpitation or pain.

These two cases are clinical illustrations of the findings of Owen, Ivy, *et al.*, namely, that biliary tract disease, especially when it produces jaundice, sensitizes the cardiac mechanism and is prone to induce these irregularities reflexly through a pathway which, their experiments indicate, involves the right splanchnic and vagus.

When a careful study fails to reveal cardiac disease it is then necessary to seek the causes previously mentioned, some of which can be revealed only by roentgen examination. (It must be emphasized here that in cardiospasm and esophageal lesions the roentgen examination must be made while the patient is having symptoms, otherwise disorders of this type may escape detection.)

Of the organic lesions responsible for the production of referred pain to the precordium, as with the irregularities, gall-bladder disease is the most common. It is a concomitant of coronary arteriosclerosis with angina pectoris in approximately 60 per cent of cases, and at times differentiation is most difficult. Biliary tract disease may direct its symptomatology to the precordium, producing pain quite typically anginal in character, even so far as to radiate into the left shoulder and arm. On the other hand, angina pectoris may cause symptoms simulating gall-bladder disease. Likewise, cardiac infarction and acute gall-bladder disease may occur simultaneously, as has been demonstrated by postmortem examination.

Because of the gas distention common to gall-tract disease, the vital capacity of the lungs may be lowered to such an extent as to give rise to dyspnea, which may erroneously point to cardiac trouble. The gas distress occurring shortly after meals may simulate so-called "acute indigestion," the misnomer under which coronary disease hid for many years.

It must also be remembered that angina pectoris may also be induced by overeating and the symptoms may be interpreted erroneously as being of gastric origin. Usually—and this is an important sign—the onset with effort is lacking in pure gall-bladder disease, but let us not forget that this does not hold true in all cases.

ABDOMINAL DISTENTION AS A CAUSE OF CARDIAC SYMPTOMS

Aërophagia, resulting in distention of the stomach and intestines with gas, may cause distress of sufficient severity to manifest itself solely in cardiac symptomatology. Recent experimental work on the reflex visceral mechanism substantiates the clinical observations of authors who have for many years ascribed paroxysmal auricular tachycardia to abdominal distention. Dyspnea, irregularities, palpitation, and precordial pain due to undue accumulation of gas, either of functional or organic origin, may produce anxiety in patients sufficient to induce a fear of impending death. Rieder, basing his findings upon thorough roentgen investigation, believes that cardiospasm and spasm of the pars media of the stomach, together with pyloric insufficiency, are the factors that cause gastric and intestinal air distention, which produce, in turn, elevation of the diaphragm by the greatly increased pressure.

ILLUSTRATIVE CASES

Case 3. Mrs. M. H., age 27, of thin, neurotic type, suffered from attacks of abdominal distention for many years, especially in the left upper quadrant (splenic flexure). Roentgenologic study was negative except for the presence of a large amount of gas in the entire colon. Coincident with these attacks there occurred classical paroxysmal tachycardia which responded quickly to ocular pressure. The patient finally learned to avert many such attacks by prompt evacuation of the colon by means of an enema, as soon as she felt any discomfort. By this procedure the incidence of paroxysms was reduced from an average of twelve yearly to two during the past two years.

Case 4. Mrs. S. P. R., age 56, of nervous type, gave a history of attacks of precordial pain on effort, so much so that she was compelled to stop several times while walking on the street. Belching was profuse and afforded relief. Tachycardia and elevation of blood pressure accompanied the upsets. Physical examination, electrocardiographic and roentgenologic studies ruled out the presence of heart disease and tuberculosis. There was no evidence of hyperthyroidism. There was a large subdiaphragmatic accumulation of air caused by a distended stomach and splenic flexure, which was kinked. Relief was obtained by gastric lavage and flushing the colon.

Paroxysmal tachycardia occurs chiefly in a group of individuals who are of a highly neurotic temperament. It is probably true that these individuals have a cardiac

mechanism which has a low threshold to stimulation, since all persons do not suffer from tachycardia merely as a result of gaseous distention. The fact that this tachycardia is usually quickly terminated by vagal pressure in the neck or pressure on the eyeballs (ocular reflex of Aschner) points to its reflex origin and its connection with the pathways of the central nervous system. The pathways here in operation are probably the same as described by Ivy in his experiments, namely, right splanchnic and vagus.

It is not uncommon in abdominal distention to find sino-auricular bradycardia. Here the mechanism is most likely reflex through the cranio-sacral system. In ordinary sino-auricular tachycardia it is possible that the acceleration (sympathetic) mechanism is at fault, and likely this is entirely reflex in origin. Whether these two systems act independently or in algebraic summation probably depends on the threshold for stimulation of these systems in any one individual.

The action of these great systems is diametrically opposed, and it must be remembered that every viscus derives its supply from both.

Illustrative of sino-auricular tachycardia caused by gas distention is the following case.

Case 5. Mrs. O., age 37, suffered frequent attacks of paroxysmal palpitation for which no cause could be ascertained after thorough clinical and roentgenologic study. At the time of roentgen examination she was free of symptoms. The patient stated that during the attacks she was greatly disturbed by gas and that belching afforded relief. To determine if its presence would precipitate an attack, air was introduced into the stomach under fluoroscopic control, through a duodenal tube, until moderate distention occurred. The pulse rate prior to the introduction of the air was 68 per minute: shortly after the air was injected the patient complained of feeling faint and the pulse rate rose to 120 per minute. She commented that the symptoms experienced were similar to those which prompted her to seek medical relief.

Therefore, in the course of roentgen examination of patients with cardiac symptoms the discovery of a large gas-bubble in the stomach or distention of the intestines causing left diaphragm elevation should not be ignored. Such a finding and its clinical significance should be stressed in the report of the roentgenologist. This may be the only means of excluding a false diagnosis of heart disease in this type of case.

SUMMARY

The history, physical examination, roentgenologic and cardiographic studies of patients with cardiac symptoms in many instances fail to reveal the existence of heart disease.

Cognizant of the numerous organic lesions and functional derangements of various organs that might produce heart symptoms reflexly, the roentgenologist may often determine the cause and establish a correct diagnosis by examination of the gastro-intestinal tract, lungs, mediastinum, and skeletal system.

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EDITORIAL

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RADIATION THERAPY

We have often wondered why so few physicians acquaint themselves with the indications for and uses of radiation therapy. It is apparent that a great number believe its use to be limited to a few diseases, and, at that, only as a palliative measure. Then again, there are some who have seen evidence of its effectiveness in the treatment of cancer, yet are reluctant to accept it or even to concede it its just place in the treatment of this disease. Surely this lack of knowledge is not due to sparsity of radiologic literature in this country, because we have at present two splendid radiologic journals issued monthly, publishing interesting scientific articles on irradiation therapy contributed by radiologists of international repute. The radiologic profession of this country is kept constantly informed of the latest progress in irradiation therapy as practised in this and other countries. There is also a not inconsiderable library of textbooks and atlases on radiology, which is constantly growing. Unfortunately, the splendid accomplishments in the cure of cancer with radiation therapy, resulting from long and continuous scientific research in the fields of physics and biology, are known to but few physicians. Of course, in a general way it is known that x-ray and radium are being used in the treatment of cancer, but few are familiar with the splendid results which are being obtained with these agents when used by experienced radiologists.

This branch of radiology has progressed rapidly in recent years, due in great part to the co-operation of engineers and physicists who have made it possible for American manufacturers to build x-ray apparatus of great magnitude and precision. Radiologists are now able to give most of their time and energy to a comprehensive study of the practical application of the very short wave lengths made possible by the new and powerful transformers. It is possible that internists and surgeons have not kept abreast of the accomplishments in radiation therapy, or noted the recorded cures. Radiologists, on the other hand, are hesitant to report their results until they can speak with surety of 5-year cures. It is not uncommon, when addressing a general medical meeting, or even a class of students, on the subject of radiation therapy, to observe a smile of doubt, as much as to say, "Do you really believe this to be true? Well, I don't. You mean well, but you are an enthusiast." One of the main reasons for this apparent skepticism is that but comparatively few have informed themselves in regard to the application of x-ray and radium as therapeutic measures. In the case of students, to be sure, time and study may widen their horizon. While it is true that there is an abundance of radiologic literature on this subject, it is, unfortunately, read by a limited group of specialists. On the other hand, surgical literature on the treatment and cure of cancer finds its way to thousands of physicians practising all forms of medicine, through journals having wide circulation.

An example of the manner of disseminating such knowledge is found in the February, 1934, issue of "Surgery, Gynecology and Obstetrics." A symposium on the curability of cancer is presented in this issue and sponsored by a number of prominent surgeons. The interesting statistics thus presented on the 5-year clinical cure of cancer have reached the large number of physicians who are readers of this magnificent medical journal. It is inevitable that they will become more and more impressed with the value of the surgical treatment of cancer and less and less with that of irradiation therapy.

We have but words of praise for the editorial policy of "Surgery, Gynecology and Obstetrics" and the surgical contributors to this interesting symposium on the curability of cancer, which no doubt will enhance the value of surgery in the treatment of cancer. It is true that certain radiologic statistics are interspersed with the surgical ones, however, there are no radiologic statistics on the curability of cancer by radiation therapy alone as practised in the United States or Canada. The point is that, if the symposium is to cover adequately the field of curability of cancer, radia-

tion as well as surgery should be included in the statements. If the symposium covers only the narrower field of surgery in the cure of cancer, then it is in order for radiologists to report on their results in a symposium of their own. Yet there should be no rivalry between the two methods—that would be contrary to the very spirit of the medical profession. Let cures be effected by whatever methods are adequate: surgeons and radiologists are co-workers, not competitors. It should be remembered, however, that the cancer problem is as much a radiologic one as it is surgical, and radiologists can also report a substantial number of cancer cures by radiation therapy. To return to the symposium, certain statistics are reported by gynecologists, yet these, as might be expected, do not represent what is being accomplished in the hands of radiologists, and in a certain instance the reported statistics are of no value and place radiology in an unfavorable and unjust light. The author, in reviewing certain statistics from 1917 to 1926 in which radiation therapy was used in conjunction with surgery either pre-operatively or post-operatively, or both, in cases of radical operation for breast carcinoma, concludes that no material difference in the percentage of 5-year cures could be determined between the irradiated cases and those without irradiation therapy. Yet the same author in another part of his paper admits that the form of irradiation used does not compare with the present-day effectiveness of radiation therapy. He says: "The dosage of x-ray given in those years, however, was much more superficial and undoubtedly less effective than that used to-day." Why make comparison between radiation therapy and surgery in such an instance? Why say that it was of no benefit, when it is admitted that the type used was ineffective? This can do irradiation only harm. We are convinced that the author had no such thought in mind when presenting his report, nevertheless those reading his statistics may accept his conclusions.

Radiologists are convinced that cancer is curable under certain conditions when all modern methods are employed by competent and experienced physicians, each in his own field.

What a great difference it would make if the general surgeon knew as much about the principles of radiology as the general radiologist knows about the fundamental truths of surgery. It would do away with that feeling of skepticism which too often surgeons have toward irradiation therapy. They would learn that in many instances instead of losing cases, they would be the beneficiaries, as the medical profession and the public would learn that cancer can be more surely and more often cured by the combined methods of treatment.

We, as radiologists, know of the splendid results now being obtained in the treatment of cancer and other diseases by radiation therapy, but our knowledge of this fact is not sufficient—we must carry it to our medical confrères with accurate and indisputable proofs in the form of reliable statistical studies. No definite constructive effort has ever been made that we know of to gather accurate statistics on 5-year cures of cancer with radiation therapy. This should be done, the statistics to be gathered not only from a few of the outstanding radiologic clinics, but from all radiologists in therapeutic practice. A résumé of progress during the last few years, when it has accomplished so much, should also be obtained, all of which will not only serve as an educational survey for physicians seeking knowledge on this subject, but will be of incalculable value to the radiologists themselves who seek to improve their methods of treating disease with radiant energy.

Some may say that the time is not propitious for such a survey—that we should wait until we are all in agreement as to the best manner of attacking cancer with radiation therapy. We cannot share in such an opinion, for well-informed radiologists all over this country are using more or less standardized forms of therapy. In substantial proof of this, it is necessary only to refer to our radiologic literature. There is no better time than the present to initiate such a movement. It can do no harm and may do a great good. We owe it to cancer sufferers and to ourselves.

The Editor of RADIOLOGY is willing to initiate such a survey if the radiologists are interested. If they believe it to be a constructive idea, let them make known their reactions, whereupon we shall seek the cooperation of all radiological societies and set in motion the proper machinery.

ANNOUNCEMENTS

TWENTIETH ANNUAL MEETING

The Twentieth Annual Meeting of the Radiological Society of North America will be held in Memphis, Tenn., Dec. 3–7, 1934, inclusive. The following Committees have been appointed, and they, with the co-operation of the members, are prepared to see the meeting through to a successful climax. This is none too early to lay plans to attend.

General Arrangements Committee:

W. S. Lawrence, M.D., *Chairman*

Other members of this committee are the Chairmen of the various special committees.

Transportation and Commercial Exhibits:

(*a*) Charles H. Heacock, M.D., *Chairman*
I. S. Trostler, M.D. (Chicago)
A. L. L. Bell, M.D. (Brooklyn)

(*b*) Local Transportation Committee:
S. W. Coley, M.D., *Chairman*
J. Cash King, M.D.
James L. Dubrow, M.D.

Entertainments:

(*a*) Sports:
W. R. Bethea, M.D., *Chairman*
W. B. Anderson, M.D.
W. A. Runkle, M.D.

(*b*) Luncheon and Banquet:
R. Paine, M.D., *Chairman*
W. R. Bethea, M.D.
W. S. Anderson, M.D.

(*c*) Ladies (Doctors' wives):
Conley H. Sanford, M.D., *Chairman*
Mrs. W. S. Lawrence
Mrs. H. N. Pulliam

Registration and Housing Committees:

(*a*) Hotel:
J. Cash King, M.D., *Chairman*
Charles M. Hamilton, M.D. (Nashville)
John M. Frere, M.D. (Chattanooga)

(*b*) Registration Committee:
John H. Herring, M.D., *Chairman*
Franklin B. Bogart, M.D. (Chattanooga)
I. A. Beale, M.D. (Greeneville)

(*c*) Scientific Sessions:
Horace D. Gray, M.D., *Chairman*
Frank W. Smythe, M.D.
John H. Herring, M.D.

Publicity and Education:

M. J. Hubeny, M.D., *Chairman* (Chicago)
D. A. Rhinehart, M.D. (Little Rock)
J. Howard King, M.D. (Nashville)

Scientific Exhibit:

W. W. Robinson, M.D., *Chairman*
E. R. Rapp, M.D.
W. T. Black, M.D.

Clinic Committee:

E. G. Campbell, M.D., *Chairman*
S. S. Marchbanks, M.D. (Chattanooga)
Max Henning, M.D.

PROGRAM OF THE NINETEENTH ANNUAL MEETING OF THE AMERICAN RADIUM SOCIETY

Time.—Monday and Tuesday, June 11 and 12, 1934.

Place.—Empire Room, Hotel Cleveland, Cleveland, Ohio.

9:00 A.M. Executive Session

10:00 Scientific Session
Address of the President, Rollin H. Stevens, M.D., Detroit
Symposium on Radium Dosage and Technic
I. Physical and Biologic Factors
Chairman, George E. Pfahler, M.D., Philadelphia

10:20 Physical Determination of Radium Dosage, Otto Glasser, Ph.D., Cleveland

10:30 Physical Factors in Teleradium Dosage, Wilhelm Stenstrom, Ph.D., Minneapolis

10:40 Physical Factors in Intracavity Radium Dosage, James L. Weatherwax, Ph.D., Philadelphia

10:50 Physical Factors in Interstitial Radium Dosage, Edith H. Quimby, Ph.D., New York City

11:00 *Drosophila* Eggs for Radium Dosimetry, George Packard, Ph.D., New York City (by invitation)

11:10 Clinical Considerations Influencing Radium Dosage, Maurice Lenz, M.D., and J. R. Freid, M.D., New York City

11:25 Microscopic Structure of Oral Cancer and its Relation to Radiosensitivity, Arthur P. Stout, M.D., New York City (by invitation)

11:40 Microscopic Structure of Carcinoma of the Uterus and its Relation to Radiosensitivity, Charles C. Norris, M.D., Philadelphia

Discussion opened by:
Francis Carter Wood, M.D., New York City
J. E. Gendreau, M.D., Montreal, Canada
George E. Pfahler, M.D., Philadelphia

Monday, June 11, 1934

Afternoon Session

2:00 P.M. Executive Session

2:30 Scientific Session
II. Benign Lesions
Chairman, Rollin H. Stevens, M.D., Detroit

2:30 Benign Lesions of the Skin, Lawrence R. Taussig, M.D., and Howard Morrow, M.D., San Francisco
Discussion: William S. Newcomet, M.D., Philadelphia

2:45 Benign Lesions of the Uterus, James A. Corscaden, M.D., New York City

3:00 Benign Uterine Hemorrhage, Henry Schmitz, M.D., Chicago
Discussion: Charles C. Norris, M.D., Philadelphia
Carl R. Crutchfield, M.D., Nashville

3:15 Benign Lesions of the Eye, Ear, Nose, and Throat, Allen G. Robinson, M.D., New York City

3:30 Chronic Infection of the Parotid Gland, G. M. Dorrance, M.D., Philadelphia
Discussion: Zoe A. Johnston, M.D., Pittsburgh

Annual Dinner

7:00 P.M., Monday, June 11, 1934
Rose Room, Hotel Cleveland
Presiding Officer, President Rollin H. Stevens, M.D.

Janeway Lecture

Recent Advances in Experimental Cancer Research
Francis Carter Wood, M.D., New York City

Tuesday, June 12, 1934

Morning Session

9:00 A.M. Executive Session

9:30 Scientific Session
III. Malignant Neoplasms
Chairman, George W. Grier, M.D., Pittsburgh

9:30 Carcinoma of the Skin, Harold N. Cole, M.D., and J. R. Driver, M.D., Cleveland (by invitation)

9:45 Carcinoma of the Cheek, Hayes E. Martin, M.D., New York City, and Otto H. Pflueger, M.D., San Francisco (by invitation)

10:00 Carcinoma of the Tongue, Frank E. Simpson, M.D., Chicago

10:15 Carcinoma of Tonsil, Larynx, and Pharynx, Max Cutler, M.D., Chicago

10:30 Carcinoma of the Cervical Glands, Douglas Quick, M.B. (Tor.), New York City

10:45 Carcinoma of the Breast, Grantley W. Taylor, M.D., Boston (by invitation)

11:00 Carcinoma of the Fundus Uteri, H. H. Bowing, M.D., Mayo Clinic, Rochester, Minn.

11:15 Radium Treatment of Carcinoma of Cervix Uteri (Moving Picture Demonstration), Lawrence A. Pomeroy, M.D., Cleveland

11:25 Carcinoma of the Bladder, Benjamin S. Barringer, M.D., New York City

11:40 Carcinoma of the Rectum, William M. Shedden, M.D., Boston (by invitation)
Discussion opened by George W. Grier, M.D., Pittsburgh
General Discussion: Limited to 3 minutes each

Tuesday Afternoon, June 12, 1934

2:00 P.M. Executive Session
Election of Officers

2:30 P.M. Scientific Session
IV. Miscellaneous Problems
Chairman, J. E. Gendreau, M.D., Montreal, Canada

2:30 Complications and Injuries in Radium

Therapy, Ira I. Kaplan, M.D., New York City

2:40 The Use and Abuse of Interstitial Radium Therapy, Albert Soiland, M.D., Los Angeles

2:50 Hazards in the Use of Radium, J. M. Sittenfield, M.D., New York City

3:00 Design of a Flexible Radium Bomb with Adequate Protection, Delivering a Homogeneous Field of Irradiation at Various Distances, William S. Newcomet, M.D., and B. A. Hughes, M.D., Philadelphia (by invitation)

3:10 A Small Platinum Needle Designed for the Use of Various Strengths of Radium Element Interstitially, Norman Treves, M.D., New York City

3:20 Correction of Dietary Errors in Connection with Radium Treatment, D. T. Quigley, M.D., Omaha

3:30 Adenocarcinoma of the Oral Cavity, William L. Watson, M.D., New York City (by invitation)

3:40 Intraperitoneal Insertion of Radon and Gastro-enterostomy in Carcinoma of the Pyloric End of the Stomach, Isaac Levin, M.D., New York City

3:50 Abdominal Implantation of Radon Seeds Combined with Removal of Iliac Glands in the Treatment of Cancer of the Cervix (28 cases), Fred J. Taussig, M.D., St. Louis

General Discussion: Limited to 3 minutes each

TENNESSEE RADIOLOGICAL SOCIETY

At the time of the recent meeting of the Tennessee State Medical Association, in Chattanooga, the radiologists of Tennessee met and organized the Tennessee Radiological Society, with the following officers:

Charles M. Hamilton, M.D., of Nashville, *President;* Charles H. Heacock, M.D., of Memphis, *Vice-president;* Franklin B. Bogart, M.D., of Chattanooga, *Secretary-Treasurer.*

The Society expects to meet annually at the time and place of the Tennessee State Medical Association meeting.

AMERICAN BOARD OF RADIOLOGY

EXAMINATIONS

The examinations of the American Board of Radiology will take place in Cleveland, June 10, 11, and 12; in Pittsburgh, Sept. 22, 23, and 24, and in Memphis, Dec. 1, 2, and 3, all of this year. Applicants should make inquiry from the Secretary-Treasurer, B. R. Kirklin, M.D., Mayo Clinic, Rochester, Minnesota.

REPRINTS AVAILABLE

Dr. I. S. Trostler wishes to announce that a few reprints of papers covered by Footnotes 1, 2, and 3 of his paper in this issue are obtainable by those interested. It is necessary only to send a large stamped self-addressed envelope to him, with the request.

BOOK REVIEWS

ROENTGEN ATLAS OF PULMONARY DISEASES (RÖNTGENATLAS DER LUNGENERKRANKUNGEN). An Introduction for Physicians by DR. W. BREDNOW, Teacher of Internal Medicine and Roentgenology, University of Göttingen, and DR. E. HOFMANN, Roentgenologist for the City Hospital, Wuppertal-Barmen. Second edition; 207 pages, and 105 full-page roentgenograms. Published by Urban & Schwarzenberg, Berlin, 1933. Price not stated.

The difficulties incident to the production of a satisfactory atlas of roentgen diagnosis, particularly in the field of pulmonary diseases, are well demonstrated in this volume. In spite of its 108 beautifully reproduced and well selected illustrations, there are numerous sins of omission. In so small a book the authors would have been better advised to have restricted themselves to the diseases of the lungs alone rather than to attempt to cover pleural and mediastinal conditions as well.

It is stated in the introduction that this atlas is intended especially for the practising physician, and, as such, it is quite acceptable. The excellent character of the illustrations and the brief but clear description of the cases are

to be highly commended. The authors state frankly that they have not attempted to illustrate any but the most common types of pulmonary disease. Nevertheless, the complete omission of atelectasis, foreign bodies, iodized oil examinations, and the minimal consideration of other non-tuberculous inflammatory diseases leaves much to be desired. The pleural conditions are likewise treated inadequately, and the infrequent use of the lateral view is to be criticized.

The section on tuberculosis represents almost half of the volume, and on the whole, this disease is well presented. The authors' views on the development of parenchymal lesions and their classification in exudative, productive, and cirrhotic types are essentially sound. The plates illustrating the various manifestations of pulmonary tuberculosis, and the effects of different methods of treatment are excellent.

The details of technic and the description of the normal chest are briefly treated in the introduction. American roentgenologists will probably agree heartily with the warning that fluoroscopic examination will frequently fail to reveal minimal and moderately advanced lesions in the lungs. There may, however, be some disagreement with the authors' estimation of the value of paper film.

On the whole, this atlas is valuable as an introduction to the study of the roentgen diagnosis of chest diseases, particularly tuberculosis, for students and physicians who are inexperienced in roentgen diagnosis. For the mature roentgenologist it has relatively little to offer.

A TEXT-BOOK ON ROENTGEN AND RADIUM THERAPY. Edited by FELICE PERUSSIA, Ordinary Professor of Medical Radiology of the Royal University of Milan, and ENZO PUGNO-VANONI, Extraordinary Professor of General Electrical Technic of the Royal School of Engineering of Padova. With the collaboration of Prof. O. Alberti, Prof. M. L. Asti, Prof. E. Bortoni, Dott. L. Gallavresi, Prof. F. Giongo, Dott. G. Giraudi, Dott. F. Mascherpa, Dott. G. Meda, Dott. M. Pellini, Dott. C. Picchio, and Prof. A. Ratti. Two volumes, about 1,600 pages, with many tables, 721 figures and illustrations (seven in colors). Fratelli Treves, Editori, Milan, 1934. Price, bound, 350 lires.

This is the most complete text-book on radiotherapy published in Italian. It embraces with due and sufficient detail the physical and biologic fundamentals which underlie the clinical application of radiotherapeutic procedures without entering into the more theoretical or controversial questions with which many similar texts are loaded. It does not, on the other hand, seem to have omitted many things of actual importance. This nice balance has been reached by a well chosen linkage of many papers, each written by a specialist in his particular field, so that a well-rounded presentation results with each subject given its due prominence.

In the first volume (of 701 pages) Pugno-Vanoni takes up the fundamentals of the modern physical theory of radiations, then a review of apparatus and dosimetry, then Giongo discusses the emission and absorption of roentgen, and Asti of radium, radiation. Picchio complements these sections with some excellent tables, helpful in dosage problems. Gallavresi presents a fine consideration of the fundamental biologic concepts, and Ratti concludes with an exposition of the reactions and injuries likely to be encountered in radiotherapy.

The second volume (of 875 pages), which is clinical, opens with a general discussion by Perussia of the elementals of the radiotherapy of tumors, which is elaborated and developed by Ratti. Benign uterine hemorrhage is discussed by Bortoni. Next Alberti takes up inflammatory disease; Giraudi, the treatment of tuberculosis, and Meda the lymphoblastomas and the diseases of the hematopoietic system. Pellini considers the field of internal medical diseases, then Mascherpa writes on the radiotherapy of diseases of the endocrine and nervous systems, Giraudi those of the bones and joints, and Perussia closes with an excellent discussion of radiotherapy in dermatology.

At the end of each chapter there is a bibliography of the important works in the field in point. Throughout the whole text extracts of clinical histories, supplemented by photographs (often in color) or radiographs serve to vivify not only the presentation of special clinical problems of radiotherapy, but also the special technic or apparatus required to carry out the treatment are illustrated profusely with photographs and diagrams. Each volume has an excellent index which facilitates reference to items in the mine of information in the text.

The fact that this work is in Italian need not bar the English-speaking radiologist from reading it, for, as a matter of fact, anyone can get the gist of the subject matter, and the help of a little dictionary will enable one to follow the text literally. The authors and publishers deserve great commendation for bringing out what your reviewer considers the best text-book on radiotherapy published up to date in any language.

Hotel Peabody, Memphis, meeting place for the Radiological Society of North America, Dec. 3–7, 1934.

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J. E. Habbe, M.D., of Milwaukee
H. W. Hefke, M.D., of Milwaukee
E. T. Leddy, M.D., of Rochester, Minnesota
Davis H. Pardoll, M.D., of Chicago
E. A. Pohle, M.D., Ph.D., of Madison, Wisconsin
Charles G. Sutherland, M.D., of Rochester, Minn.

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APPARATUS

A New Apparatus for the Improvement of the Protection of Radiologist and Technician when Working with Radio-active Substances. W. Schaefer and E. Witte. Strahlentherapie, 1933, XLVI, 568–573.

A number of accessories are described which permit the preparation and handling of radium screens and plaques with a minimum of exposure to the hands of the operator. The article is profusely illustrated.

ERNST A. POHLE, M.D., Ph.D.

Electrical Accidents: Critical Considerations about a Number of Electrical Accidents in Medical Roentgen Laboratories. G. Grossmann. Röntgenpraxis, April, 1933, V, 269–286; May, 1933, V, 354–363.

During the last two years shock-proof roentgen apparatus has been developed which does away with the dangers connected with the older type of apparatus. Till the old apparatus for therapy and diagnosis is displaced by shock-proof installations the matter of electrical accidents is of great importance. The author has collected 25 cases from the literature and the files of roentgen laboratories in order to investigate whether or not the rules and regulations published in the German "Fortschritte der Röntgenstrahlen," 1932, are sufficient to prevent such accidents. Many accidents attributable to high tension currents have not been reported

in the literature, either because they did not cause much harm or because publicity was not desired.

Of these 25 cases reported in this article, in nine the death of the person was caused by his coming in contact with the high tension wire. The description of the accidents, the suggestions to prevent them, and the conclusions reached by the author of this rather extensive paper are worth while reading for roentgenologists who still have to work with the old overhead type of high tension wires. The author believes that no such apparatus should be installed in any roentgen institute but that only shock-proof apparatus should be permitted.

H. W. HEFKE, M.D.

A New Apparatus for the Testing of the Seals of Radio-active Preparations. E. Witte. Strahlentherapie, 1933, XLVI, 374–377.

This is a description of an apparatus which easily permits the detection of leakage from a sealed radon applicator.

ERNST A. POHLE, M.D., Ph.D.

Experimental Studies about the Photographic Treatment of Roentgen Films. Richard Herz and Fritz Luft. Röntgenpraxis, July, 1933, V, 520–529.

According to a publicaton of Lewin, it should be possible to reduce exposure time to one-fourth of the normal when the exposed films are submerged in water before developing and when they are frequently moved in the developing solution. The authors have repeated these experiments and have found that in the most favorable case the developing time might be reduced somewhat, but that it is not possible to shorten the exposure time by this method. They investigated also a fact known to photographers: the increase in contrast by exposing the film to a very small amount of light before or after exposure. Such an increase in contrast is possible but only with a loss of clearness. This method, therefore, can hardly be recommended except for certain occasions (for instance, extremities) when a slight haziness is of no importance.

H. W. HEFKE, M.D.

A Special Fixation Apparatus for Intra-esophageal Radium Application. Theodor Körner. Strahlentherapie, 1933, XLVII, 557–561.

The author describes an appliance which permits the fixation of a radium preparation in the esophagus. Photographs appended to the article show the construction and the use of the apparatus.

ERNST A. POHLE, M.D., Ph.D.

Adjustable Protective Treatment Screen. Géza Györgyi. Strahlentherapie, November, 1933, XLVIII, 592–594.

The author describes a protective device to be used in roentgen therapy, consisting of a stand with adjustable lead screen, particularly helpful in treating patients in the sitting position.

ERNST A. POHLE, M.D., Ph.D.

The Operation of Therapy Tubes on Different Types of Apparatus. Walther Müller. Strahlentherapie, January, 1934, XLIX, 132–140.

The author compared the circuits designed by Greinacher-Liebenow, Villard, and Witka, in x-ray therapy apparatus. He found that the first one mentioned, delivering almost a constant potential, is superior to the others.

ERNST A. POHLE, M.D., Ph.D.

Detail and Sensitivity of Roentgen Paper. H. Chantraine. Röntgenpraxis, April, 1933, V, 287–290.

In roentgen paper not only the range of contrast is much narrowed, but the detail is also much lessened, when compared with roentgen films. Of the good qualities which the roentgen paper is supposed to have, there is only one really proved: that is its cheapness. However, if a thing costs little and is not worth more than it costs, there is no cause for praising it. The high sensitivity of roentgen paper does not help much. A high sensitivity should give good detail in moving objects, but the roentgen paper reproduces moving or quiet objects with equally poor result. If one wishes to be able to say that a record has been made, then one may let the roentgen paper take the place of a film. It is apparent from the above quotations that the author does not think much of roentgenograms made on paper.

H. W. HEFKE, M.D.

ARTHRITIS

Articular Osteochondromatosis of Reichel. Antonio Masturzi. Archivio di Radiologia, 1933, XII, Nos. 5 and 6, pp. 970–1005.

Masturzi reports and illustrates 10 cases of this lesion, in eight of which there was good evidence for accepting trauma as an important etiologic factor. Only one case gave evidence of arthritis deformans; another had an inflammatory lesion following trauma. Diagnosis of the lesion in question is possible only after roentgenologic study which, at the same time, will give invaluable criteria for the treatment.

E. T. LEDDY, M.D.

Management of Gonorrheal Arthritis. D. W. Hedrick. Am. Jour. Surg., November, 1933, XXII, 255–261.

Ammonium iodoxy benzoate is of definite value in the treatment of gonorrheal arthritis. It is best used as an adjunct to the usual orthopedic measures: (1) short period of rest, preferably in plaster, for from four to ten days; (2) physical therapy, diathermy, massage, and active motion as soon as the pain disappears. In the milder cases its use permits a patient to be ambulatory who might otherwise be confined to the hospital.

Insufflation of the knee in the synovial type of gonorrheal arthritis is described. The author feels that it hastens resolution of the process, promptly relieves pain and thus permits early motion, preventing the formation of intra-articular adhesions and muscular atrophy from prolonged immobilization.

Aspiration, irrigation, or even drainage is sometimes necessary for the purulent type of infection, but amiodoxyl again seems to hasten the resolution and certainly relieves the discomfort. Splinting in a position of rest is necessary for a time, but early motion should be started as soon as the acute stage is over and pain is relieved. With this, diathermy and massage have been found to constitute the most valuable type of physical therapy.

Hyperpyrexia by fever diathermy is useful, especially in refractory cases.

Twenty-two cases are reported, 11 of which were treated with the adjuncts already described. Of these, 40 per cent were completely cured, 40 per cent much improved, and 20 per cent developed ankylosed but painless joints. The remaining 11 are presented for comparison and received no amiodoxyl, insufflation, nor hyperpyrexia therapy. Of these, 30 per cent showed no improvement; 10 per cent recurred; 20 per cent resulted in ankylosis; 40 per cent showed slight improvement.

DAVIS H. PARDOLL, M.D.

BONE DISEASES (DIAGNOSIS)

Protruding Acetabulum and Accident. Fritz Berent. Röntgenpraxis, April, 1933, V, 303–306.

In two cases of characteristic protrusion of the acetabulum it could be shown that an accident which was supposed to be the cause had no bearing in it. In one case roentgenograms taken years before the accident had already shown a bilateral protrusion. There are cases of protrusion of the acetabulum, the etiology of which is unknown and which progress very slowly. Some cases show only moderate protrusion of the acetabulum into the pelvis, without deformity of the head of the femur or of the acetabulum itself. These patients complain of no, or very slight, symptoms. In other cases there is marked destruction and deformity of all bones forming the hip joint. These patients have definite objective and subjective symptoms, similar to those from a complete ankylosis.

H. W. HEFKE, M.D.

Pathology of the Symphysis. G. M. Sack. Röntgenpraxis, August, 1933, V, 566–576.

Roentgenologic considerations of the symphysis have been greatly neglected. It has its greatest width during fetal life and decreases in width up to the tenth or twelfth year. From then on it remains about the same until old age, when it becomes still narrower. A great number of variations in the shape of the symphysis are normal. Some of the differences in shape apparent in roentgenograms, however, are due to the oblique direction of the central ray and to projection. The developmental anatomy as gone into by the author, includes old age and normal static stress which lead to anatomic changes of the symphysis just as in the spine. Pathologic changes are also caused by deformities of the pelvis and hips. A real joint might be found in a woman after several pregnancies. Osteoarthritic changes are common in advanced age, sometimes even forming osseous bridges. Degenerative changes in the ligaments are sometimes evidenced by areas of calcification. Complete bony ankylosis of the symphysis is not seen often in roentgenograms. Prolapse of cartilage (analogous to the Schmorl's bodies of the spine) has been seen by a pathologist, but is difficult to demonstrate on roentgenograms. Acute infections and tuberculosis of the symphysis are not rarely encountered, especially in puerperium. Trauma due to labor predisposes to it. Metastases of malignant tumors have been described; of primary tumors, chondrosarcomas are most frequently encountered. Ruptures of the ligamental apparatus of the symphysis are seen after fractures of the surrounding pelvic bones or even in normal labor. Often separation of the pubic bone is combined with it, when the injury has been sufficiently severe.

H. W. HEFKE, M.D.

Post-traumatic Cystic Disease of the Carpal Bones. L. A. Malone. Am. Jour. Roentgenol. and Rad. Ther., May, 1933, XXIX, 612–616.

Instead of the many individual names applied to certain diseases of the carpal bones, such as Kienböck's disease, Preiser's disease, traumatic osteoporosis, traumatic malacia, secondary post-traumatic malacia, chronic osteitis, and osteodystrophia cystica, the author recommends the use of the single inclusive term of "post-traumatic cystic disease of the carpal bones." The trauma contributing to the process may be: (*a*) abnormal pressure resulting from associated anomalies; (*b*) repeated minor occupational injuries; (*c*) severe trauma. Such trauma eventuates in permanent (or, more rarely, transient) disturbance of nutrition, and may be due to detachment of the ligamentum naviculolunatum, which contains the main nutrient vessel, or to interosseous hematoma formation. Conditions to be differentiated are tuberculosis, syphilis, nonspecific arthritis, congenital anomalies, central bone abscesses, and tumors. The author presents five cases, in three of which cystic changes were present

in both the navicular and lunate bones. In two of the cases, there had obviously been old ununited fractures of the navicular in addition to the cystic changes.

J. E. HABBE, M.D.

BONE DISEASES (THERAPY)

Osteosclerosis of the Pelvic Bones as an Early Symptom of Osteitis Deformans (Paget). Franz Polgár. Röntgenpraxis, July, 1933, V, 487–494.

Bársony and Polgár described, in 1928, an osteitis condensans ilia which is typified clinically by sacro-iliac symptoms and pain radiating into the lower extremities. Roentgenologically it shows a more or less extensive osteosclerotic process of the os ilium, usually beginning just beside the sacro-iliac joint. Sometimes the superior ramus of the os pubis is the only bone attacked. The thickening of the cortex is uneven in some cases (periosteal bone apposition). In one case the author had occasion to demonstrate a definite advance of the changes in five years. There may be not only productive bone changes but also regressive changes (decrease of calcium content in some areas and formation of cyst-like spongiosa spaces). The opinion of the author at present is that this osteitis condensans is a forerunner, and an initial stage, of Paget's disease of the pelvic bones. Pathologic-anatomic studies are not available as yet.

H. W. HEFKE, M.D.

Roentgen Therapy of Tuberculosis of Bones and Joints. H. Holfelder. Strahlentherapie, December, 1933, XLVIII, 771–775.

Roentgen therapy of tuberculosis of the bones and joints has been successful in the author's clinic. The single dose amounts to from 130 to 150 r (in air). The more acute the process, the smaller the dose. Some cases, with marked abscess formation and fistula, may require from 300 to 450 r. Deep therapy technic should be used.

ERNST A. POHLE, M.D., Ph.D.

Osteomyelitis of the Ilium. Carl E. Badgley. Arch. Surg., January, 1934, XXVIII, 83–124.

The author finds a very scant literature on this subject, especially on the chronic type of osteomyelitis of the ilium. He reports 24 cases of this condition, out of which number 17 have been completely cured.

Resection of the wing of the ilium was done 12 times, partial resection of the anterior or posterior thirds in 5 cases, removal of the outer table of the ilium, accompanied by saucerization of the ilium, in 4 cases, sequestrectomy and drainage in 1, and saucerization of an abscess just above the acetabulum in 2. In most cases of chronic osteomyelitis of the ilium, the author advises resection of both tables of the bone, but it is rarely necessary to do a complete resection of the bone. A very thorough discussion of all the clinical features of this condition is given in the body of the article.

HOWARD P. DOUB, M.D.

BRAIN

Cranial Osteomas and Hyperostoses Produced by Meningeal Fibroblastomas: A Clinical Pathologic Study. Francis Echlin. Arch Surg., February, 1934, XXVIII, 357–405.

Cranial osteomas may be either spongy or eburnated and arise from pre-osseous tissue on the cranial surface, as a rule, early in life. They most frequently involve the frontal bone and are very slow in their growth.

The spongy type of osteoma usually causes an absorption or spongy transformation of the outer table of the cranium and becomes continuous with the diploe. This often depresses the inner table of the skull in this region, but usually does not cause compression of the brain. This type of osteoma has often been described as arising from the diploe.

Osteomas of the cranial surface rarely arise in adults and then tend to be of a dense, eburnated type.

Hyperostoses produced by meningeal fibroblastomas can be distinguished from osteomas of the cranial surface prior to operation. Osteomas usually occur in youth and hyperostoses in the fourth decade of life. Compression of the brain commonly accompanies hyperostoses, but is rarely present with osteoma. The roentgenographic appearances are also different.

Osteomas that cause severe pressure on the brain usually arise either about the paranasal sinuses or the orbits or from the inner surface of the skull and not in the periosteal region on the cranial surface.

HOWARD P. DOUB, M.D.

The Roentgenologic Diagnosis of Brain Tumors. Godehard Goralewski. Röntgenpraxis, July, 1933, V, 506–514.

There is nothing new in this article, but it contains a short history, clinical findings, and reproductions of roentgenograms in nine cases of brain tumor and related lesions. In many cases the roentgenologic diagnosis is very much dependent on the clinical findings. In some cases special positions must be used, as Stenver's for demonstration of the petral portion of the temporal bone. In other cases neither the commonly used nor the special roentgenograms are sufficient for localization and encephalography (ventriculography) has to be done. The differentiation between hemorrhage and tumor cannot always be made clinically or roentgenologically—there is still much to be learned. The new method of arteriography and the injection of intracysternal contrast media are methods which possibly promise a new advance.

H. W. HEFKE, M.D.

CANCER (DIAGNOSIS)

Carcinoma of the Penis in Siam. T. P. Noble. British Jour. Urol., September, 1933, V, 242–248.

The author states that the estimates of the frequency of cancer in the East are open to fallacy because of the lack of an adequate system of registration of deaths, but in the case of a particular disease, fairly reliable conclusions can be reached from hospital admissions.

Cancer of the penis formed 9.6 per cent of the total admissions for cancer to the Siriraj Hospital during the four years under review. Phimosis appears to play the chief rôle in the etiology of this disease, and syphilis as a causative factor comes second. The inguinal glands, although usually enlarged, are rarely the site of a secondary cancer, according to the author.

DAVIS H. PARDOLL, M.D.

Primary Malignant Disease of the Duodenum. Sherman A. Eger. Arch. Surg., December, 1933, XXVII, 1087–1108.

Primary carcinoma of the duodenum, which is almost as frequent as carcinoma of the jejunum and ileum combined, is found in 0.033 per cent of autopsies, making the ratio of 1 to 2,780. Of the three duodenal portions, the second, or ampullary, is by far the most frequently involved. Cylindric cell adenocarcinoma is the type most frequently found. There is little evidence that duodenal malignancy arises from a simple duodenal ulcer. Metastases, even to the contiguous lymph nodes, are not common and occur very late in the disease. The diagnosis is difficult, owing to the lack of clear-cut clinical findings.

The course of the disease is usually progressive and rapid. Radical excision should be performed in uncomplicated cases.

HOWARD P. DOUB, M.D.

Epithelioma of the Auricle and Carcinoma of the Stomach. Edmondo Ingber. Arch. di Radiologia, 1933, XI, Fasc. 3, pp. 418–432.

Ingber reports a patient in whom the occurrence of two carcinomas brings in the problem of their interrelationship—whether they were two independent tumors or whether the one in the stomach was a metastasis from the ear lesion.

E. T. LEDDY, M.D.

CANCER (THERAPY)

Results of Radiation Therapy in Inoperable Carcinoma of the Cervix. Ivan von Büben. Strahlentherapie, January, 1934, XLIX, 82–91.

The author states that 305 cases of inoperable carcinoma of the cervix, out of a total of 658, were free from symptoms for one year (45 per cent) following radiation therapy. Thirty-eight patients remained well for five years, corresponding to a clinical cure of 9.8 per cent. Radium was applied in two screens of 25 mg. each, filtered through the equivalent of 1.5 mm. Pt, and left in the uterus for from 24 to 48 hours. X-ray therapy was given with the following technic: 190 K.V., 0.5 Zn + 0.5 mm. Al, 30 cm. F.S.D., 3 to 6 fields, 1,500 r per area. The patients are examined at regular intervals.

ERNST A. POHLE, M.D., Ph.D.

Combination of Radiation Therapy with Hormone from the Anterior Lobe of the Hypophysis in Carcinoma of the Female Genital Organs. Georg Ernst. Strahlentherapie, November, 1933, XLVIII, 552–561.

The author studied the combined effect of hormone of the anterior lobe of the hypophysis, and irradiation, in cases of malignant disease of the female genital organs. He could not find any definite beneficial effect of the hormone treatment. The latter was, however, very effective in cases of ovarian dysfunction.

ERNST A. POHLE, M.D., Ph.D.

Results of Cancer Therapy in the Dermatological Clinic of the University of Zürich. G. Miescher. Strahlentherapie, January, 1934, XLIX, 65–81.

The author compares the results obtained by the single massive and fractional dose methods in the treatment of skin cancer. He administers from 1,200 to 1,600 r, calculated for a field of 4 × 4 cm., without filter, or filtered through from 0.5 to 1.0 mm. Al for superficial carcinoma, and from 0.1 to 2.0 mm. Cu for deeply infiltrating carcinoma. The fractional doses amount to from 200 to 220 r in each sitting, giving a total of from 16 to 24 exposures, or from 3,800 to 4,600 r per field. The penetration of the radiation varies according to the depth of the lesion. Numerous tables are shown, on which the conclusions drawn from this study are based. It appears that the percentage of cure for skin cancer not exceeding 2 cm. diameter, obtained by the single massive dose method, is from 94 to 96.5 per cent. Carcinoma of the lip belongs to the same category. For larger tumors, the fractional dose method is the method of choice.

ERNST A. POHLE, M.D., Ph.D.

CONTRAST MEDIA

Varicography. Maurice M. Pomeranz and Isidor S. Tunick. Surg., Gynec. and Obst., November, 1933, LVII, 689–695.

The authors discuss the visualization of the venous system of the extremities, in living patients, by the injection of skiodan. The study included both normal and abnormal veins examined with the patients in the upright, vertical, and Trendelenburg positions.

The technic employed consisted of the injection of

from 5 to 20 c.c. of a 40 per cent solution of skiodan. The patient should have the usual preparation for intravenous injection, and care should be taken not to inject the solution into the surrounding tissues. The use of the tourniquet is optional unless it is desired to employ the Trendelenburg test, in which case a tourniquet is essential. If an ulcer exists in the case of pathologic veins, it is desirable to mark the location of the ulcer by means of a radiopaque marker. The authors suggest stereoscopic films, along with the usual fluoroscopic examination, for a complete study of the venous system.

Normal veins pursue a straight course with gentle curves but without kinks or tortuosities. The caliber is uniform and the terminal filaments taper off gradually. Spasmodic constriction may be noted as the result of chemical irritation. The authors were able to study the valvular apparatus best in the normal veins of the arm, the valves being situated distal to the point of entrance of the communicating veins.

In the case of abnormal veins, this study revealed pathologic changes to a degree unsuspected by the physical examination. With dilatation and an apparent increase in length, loops and coils were noted, which extended in all directions. Venous pools were found to be commonly present in the vicinity of ulcers. It was also noted that many vessels became occluded by this procedure but no ill effects were observed in any case.

During the course of this investigation, the authors injected a large venous angioma with skiodan with good results, the venous dilatation being so marked that it formed a large, unsightly tumor. The patient had refused operation. Radiographic examination showed the tumor to consist of innumerable convoluted, dilated vessels, closely intertwined. Of interest is the fact that three days after the injection practically complete obliteration of the angioma was noted.

J. N. Ané, M.D.

Excretion Urography, with Particular Reference to Newly Developed Compound: Sodium Orthoiodohippurate. Moses Swick. Jour. Am. Med. Assn., Dec. 9, 1933, CI, 1853–1855.

The underlying principle of the present investigations concerns itself with the utilization of a normal product of metabolism as an organic nucleus for combination with the radiopaque element necessary for the visualization of the urinary tract. This substance is a newly developed compound: sodium orthoiodohippurate, a halogen derivative of a compound normally found in the human urine. On the basis of its use in more than 200 cases, the author has found the substance to be non-toxic, highly soluble, and neutral in solution, and to yield satisfactory urograms. It possesses 38.8 per cent of iodine in stable organic union. Iodism has never been observed. Generalized warmth and occasionally nausea and vomiting of very transient duration have been the only reactions noted. Thrombosis at the site of injection has not been observed. A solution of this substance remains unchanged in color or reaction after sterilization or on standing, and may be prepared and distributed in sterile vials ready for use. For adults, a dose between 10 and 15 gms. of substance dissolved in distilled water in approximately 50 per cent concentration has been used. Both intravenous and oral administration have yielded satisfactory results. The technic of administration by both methods is given in detail.

C. G. Sutherland, M.D.

Huge Perforation of the Duodenum, with the Escape of the Opaque Meal. M. Lambranzi. Arch. di Radiologia, 1933, XI, Fasc. 3, pp. 468–480.

The author presents a case of duodenal ulcer perforating into the liver in which the clinical diagnosis was difficult, if not impossible, to make. As the result of gastro-intestinal examination, using barium sulphate, a large hepatic perforation was demonstrated, while another examination a short time before had showed an ulcerating lesion in the bulb.

E. T. Leddy, M.D.

Iodized Oil in Bronchiectasis, Including Study of Two Cases Following Lobectomy. J. A. Weinberg. Arch. Surg., September, 1933, XXVII, 545–564.

The author reports observations on two patients who had injections of iodized oil at intervals before lobectomy. He also gives the results of experiments on animals regarding the distribution of the oil and its effect on the lungs.

He believes that all types of cells in the lungs participate in the taking up of the oil droplets. The oil remains in the lung tissue for a period of at least 83 days following the injection. In bronchiectasis, it is probable that many of the sacs of the diseased lung fail to receive oil, according to the findings in the human lung described here. Experiments on animals show that injection of iodized oil into the bronchial tree results in multiple areas of atelectasis, a condition which usually subsides after a period of two weeks. Several of the animals died from 40 to 52 days after injection. All of them showed extensive pneumonitis, due probably to the excessive amount of iodized oil which was injected. The occurrence of atelectasis and pneumonitis indicates that very small amounts of iodized oil should be used for diagnostic purposes in clinical work. In experimental animals, iodized oil is retained for a much longer period in the bronchiectatic lung than in the less diseased lung.

Howard P. Doub, M.D.

DIAPHRAGM

Physiologic Variations in the Contour of the Diaphragm Simulating Organic Disease. Harry A. Singer and William S. Boikan. Am. Jour. Roentgenol. and Rad. Ther., May, 1933, XXIX, 600–606.

Generally speaking, distortions in contour of the regulation diaphragmatic arc are considered invariably due to supra- or infra-diaphragmatic disease. There are normal physiologic variations which are not, however, generally recognized to be such. One type consists in the presence of a distinct antero-medial bulge (always right-sided). The double explanation of this normal variation (which in exaggerated form may occur in the presence of certain pulmonary lesions) is: (*a*) a disturbed relationship of muscular development of the component muscle fibers, those in the postero-lateral group being relatively stronger than the fibers on the antero-medial group; (*b*) the medial portion is inhibited in descent because of its relative fixation above to the inferior vena cava which passes through it. The other major type of contour deformity (predominantly right-sided although sometimes manifest on the left side, also) is individualization of the costal components, dependent upon the variable development of the muscle bundles arising from the lower six ribs. The resulting appearance is a series of digitations, with the scallops pointing downward and a step-like lateral ridge formation at the costophrenic angle. The phenomenon of digitization is ascribed to hypertrophy of the costal bundles, and is to be observed in athletes and in cases of compensatory hypertrophy of one side of the diaphragm in disease of the other.

Illustrations of these physiologic variations in diaphragm contour are given to show the importance of their recognition and correct interpretation.

J. E. HABBE, M.D.

GALL BLADDER (NORMAL AND PATHOLOGIC)

Changes in the Shape of the Gall Bladder by the Formation of Diverticula. W. Nagel. Röntgenpraxis, September, 1933, V, 653–659.

Changes in the shape of the gall bladder are mostly caused by pressure, pull, or fistula formation from neighboring organs (liver, duodenum or colon). Congenital membranes, the ligamentum cystico-duodenale, cystico-colicum, and hepato-cystico-colicum may also be responsible. Duplication of the gall bladder or septum formation are very rare (1 in about 3,000 or 4,000 cases). A kink in the fundus might lead to an S-formation or a gall bladder of spiral shape. Deformities caused by spasm may be excluded by antispasmodic drugs. Diverticulum-like deformities have been described in the roentgenologic literature. Their cause may be spastic contractions, excessive dilatation of Luschka's ducts, folds of the mucosa, or adhesions.

Two cases of diverticula of the gall bladder are described by the author. In the first case the roentgenologically demonstrable diverticulum was at operation seen to be due to adhesions and to a gallstone. In the second case the fundus-diverticulum was caused by adhesions from the gall bladder to the duodenum, which was the seat of a chronic duodenal ulcer. It seems necessary to exclude a congenital diverticulum, which is of no clinical importance, and to try to find the anatomic cause for the deformity either in the gall bladder or in the surrounding organs.

H. W. HEFKE, M.D.

A Contribution to Cholecystography. A. Pirazzoli. Arch. di Radiologia, 1933, XI, Fasc. 3, pp. 433–467.

Pirazzoli used the "rapid method" of cholecystography (which was introduced by Antonucci) in the study of 165 cases with symptoms of gall-bladder disease, and of this group 50 had operative control. This method is also of value in the study of cholelithiasis and of the mechanism of emptying the gall bladder.

E. T. LEDDY, M.D.

Double Formation of the Gall Bladder in Humans Demonstrated Cholecystographically. W. Braunschweig. Röntgenpraxis, August, 1933, V, 594–596.

Complete duplication of the gall bladder is rare, such an occurrence having been seen in roentgenograms only once, in a case described by Climan. Reproductions of oral cholecystograms show the presence of two gall bladders—best on the film taken twenty minutes after giving eggs for emptying the gall bladder. Each gall bladder seems to have a separate cystic duct. In some of the roentgenograms the condition could easily be mistaken for other malformations, as diverticula.

H. W. HEFKE, M.D.

GASTRO-INTESTINAL TRACT (DIAGNOSIS)

Compression and Dislocation of the Digestive Tract in Some Abdominal Affections. Mario Muzii. Archivio di Radiologia, 1933, XI, No. 4, pp. 643–681.

Muzii reports 24 cases in which there was extrinsic compression of various organs, illustrates their radiologic appearance, and points out some of the difficulties that may be encountered in diagnosing the exact nature of the deformity or displacement of the viscus.

E. T. LEDDY, M.D.

Segmentary Spasm of the Lesser Curvature of the Pyloric Antrum in the Diagnosis of Ulcerative Lesions in the Pyloroduodenal Region. Gaetano Colale. Archivio di Radiologia, 1933, XII, Nos. 5 and 6, pp. 1045–1060.

Colale describes a particular spasm of the pyloric antrum which he regards as almost pathognomonic of ulcerative lesions in the outlet of the stomach.

E. T. LEDDY, M.D.

Hypertrophy of the Pyloric Muscle of Adults: A Distinctive Roentgenologic Sign. B. R. Kirklin and Milo T. Harris. Am. Jour. Roentgenol. and Rad. Ther., April, 1933, XXIX, 437–442.

At the Mayo Clinic in the five-year period from 1927

to 1931, 81 cases of benign hypertrophy of the pyloric muscle were encountered, as proved by operation. Only one of the cases was correctly recognized at roentgenologic study prior to operation, but on reviewing the films the authors are convinced that the findings of elongation of the pyloric ring, plus crescentric indentation of the base of the bulb, constitute pathognomonic appearances. In 51 of the 81 cases, there were associated lesions such as peptic ulcer, duodenitis, chronic cholecystitis, or chronic appendicitis. Hence, the etiologic relationship between prolonged pylorospasm and benign hypertrophy is suggested.

J. E. HABBE, M.D.

The Roentgen Diagnosis of Right Paraduodenal Hernia: Report of a Case, with Survey of the Literature. Frederick B. Exner. Am. Jour. Roentgenol. and Rad. Ther., May, 1933, XXIX, 585–599.

The four regions in the posterior abdominal wall in which herniæ are apt to occur are: (1) the lesser peritoneal sac; (2) the intersigmoid fossa; (3) one of the fossæ about the cecum; (4) one of the fossæ about the duodenojejunal flexure. This last type of hernia may be subdivided into the right and left types, of which the former is the less common. Only two authenticated cases with pre-operative diagnosis have been reported prior to this time. In the small series of 40 cases of right paraduodenal hernia accepted by the author, the ratio of males to females was 5 to 1. It is characteristic of both right and left paraduodenal herniæ that they usually contain almost the entire small bowel.

The most characteristic sign of right paraduodenal hernia is a clumped appearance of the small intestinal coils as if contained in a bag, such arrangement being unchanged by manipulation or change of position. The axis of the mass of herniated loops is somewhat to the right of the midline. Only the body portion of the stomach tends to be displaced down to the left. There tends to be an absence of the small bowel in the pelvis, and the lower margin of the bowel area is convex downward instead of concave downward as in pelvic tumor. There is apt to be more or less stasis in the small bowel.

The author's case was that of a female, aged 56, who clinically showed carcinomatous masses in the pelvis and a marked ascites. Her gastro-intestinal symptoms were: attacks of pain in the right upper quadrant; intermittent bloating, and some constipation. The x-ray findings were: (1) *by enema*, pressure on rectum; slight upward displacement of sigmoid; slight medial displacement of the ascending colon; dilatation and upward displacement out of the pelvis of the terminal ileum; (2) *by barium meal*, clumped arrangement of much of the small bowel in the right mid-abdomen with, however, some dilated gas-filled loops high in the left abdomen; at nine hours, visualization of a loop of ileum near the duodenojejunal flexure, showing a sudden transition from wide to narrow caliber, interpreted as the efferent loop passing from the sac.

Operation confirmed the diagnosis of probable right paraduodenal hernia and the herniated bowel was easily reduced, but repair of the sac was not done because of the pelvic condition.

J. E. HABBE, M.D.

GENITO-URINARY TRACT (DIAGNOSIS)

Practical Application of Excretory (Intravenous) Urography. William F. Braasch. Jour. Am. Med. Assn., Dec. 9, 1933, CI, 1848–1852.

"Excretory urography" would seem to be the logical term, since it is physiologically descriptive and, in view of recent and portending advances in oral administration, would be quite acceptable. Many of the deformities of the renal pelvis will soon be roentgenologically standardized in a manner similar to lesions of the alimentary tract, so that any one with roentgenographic experience should be able to interpret most urograms with a fair degree of accuracy. Errors in interpretation undoubtedly will arise and the necessity for correlation with cystoscopic and other data will often be present. The excretory urogram will be of greatest practical value to clinical diagnosis in (1) determining the presence of stasis in the renal pelvis or ureter, (2) aiding in interpretation of shadows in the upper part of the urinary tract, and (3) giving a fairly accurate estimate of renal function. Retrograde urography is still of great value, particularly in the recognition of minor deformity, and supplies data that cannot be acquired by any other method. The data obtained from the combined use of excretory and retrograde urography will often give more complete information than when either method is used alone.

Excretory urography is frequently disappointing because of inadequate visualization of the pelvis and calices. Complete failure of visualization on one side in repeated films must be interpreted as indicative of renal dysfunction. Many cases of hydronephrosis will be diagnosed by the general practitioner which otherwise might be overlooked. The comparative degrees of ptosis and of the excursion of both kidneys in varying positions can be determined more accurately in the excretory urogram.

Excretory urography is probably more often of value to the general practitioner and surgeon in the diagnosis and study of lithiasis than in any other field. The excretory urogram will often give sufficient data either to identify abdominal tumor as renal or to exclude the possibility of its being renal. Excretory urography, when feasible, is distinctly preferable to retrograde urography in the diagnosis of polycystic kidney.

Various observers have employed this method as a routine without apparent injury to the patient and have been able to find evidence of secondary lesions in the urinary tract in a surprisingly high percentage of cases.

C. G. SUTHERLAND, M.D.

Urethrocystography in the Male. Joseph A. Hyams, Herbert R. Kenyon, and Samuel E. Kramer. Jour. Am. Med. Assn., Dec. 23, 1933, CI, 2030–2035.

Because of the close anatomic and functional relationship of the posterior urethra, adnexa, vesical neck, and bladder muscle, a more accurate concept of their morphology and function can be obtained by their simultaneous and complete delineation than from urethrography or cystography alone. Previous experience enabled the authors to develop a technic for the performance of urethrocystography by combining several procedures previously advocated by other workers with a simplified manometrically controlled syringe they devised. The technic and apparatus are described in detail. Interpretation is discussed: Advanced chronic urethritis is manifested by fairly definite changes. Demonstration of the accessory urethral structures is of diagnostic importance; normal adnexal structures do not readily permit entrance of the injected fluid. Flattening of the bladder base and irregularities in its contour may express the severity and extent of prostatic involvement. The diagnostic value in stricture of the urethra, and in benign and malignant lesions of the prostate, with its utility in observations following operations for vesical neck obstructions are discussed in detail. The authors have adopted the use of watery solutions because, in addition to fulfilling all the requirements of a satisfactory medium, they penetrate readily into the smaller canals and pockets. Iodized oils do not possess these advantages. The combined method has adequately demonstrated bladder, urethral, and adnexal changes and has proved less expensive, less time-consuming, and more satisfactory as a routine diagnostic method.

C. G. SUTHERLAND, M.D.

Solitary Cysts of the Kidney: A Review of Coexisting Pathology. Boris E. Greenberg, M. Leopold Brodny, and Samuel A. Robins. Am. Jour. Surg., February, 1934, XXIII, 271–283.

Ten solitary cysts have been encountered during the past four years on the urological service of a hospital having a capacity of 185 beds.

The etiology of solitary cysts remains undetermined. Within the last year, Hepler presented very careful experiments which advanced the theory of infarcts and tubular obstruction as factors producing these cysts. However, the experiments of Latteri, in which he produced solitary cysts by implanting fragments of the mucosa of the ureter or renal pelvis into the kidney parenchyma, added additional strength to the theory of congenital pathogenesis.

The clinical diagnosis of solitary cyst is possible. With better x-ray facilities, the diagnosis can be more frequently made, yet in the absence of adequate urologic studies, the diagnosis is often unsuspected.

Intravenous urography intensifies the roentgenographic outline of cysts, and will often demonstrate changes in the size and shape of the kidney which are not observed in retrograde pyelography.

In about 40 per cent of the kidneys which contain solitary serous cysts, additional pathologic lesions are present. Two cases of tumor of the kidney, two cases of renal calculi, and one case of cyst of the liver coexisted with a solitary cyst of the kidney in five of the ten cases reported in this paper. It is important that these co-existing lesions be recognized pre-operatively, and a plan of treatment instituted in accordance with the accepted methods for the type of lesion present.

DAVIS H. PARDOLL, M.D.

New Pyelographic Technic. Miley B. Wesson. Am. Jour. Surg., February, 1934, XXIII, 284–286.

After a routine kidney investigation, while the catheters are in position and plugged, intravenous pyelograms should be made. The patient will not be subjected to kidney colic due to pelvic irritation, and clear-cut urograms, in addition to a good outline of the kidney substance, will be obtained.

DAVIS H. PARDOLL, M.D.

GENITO-URINARY TRACT (THERAPY)

Spontaneous Perforation of the Bladder Secondary to Osteomyelitis of the Pelvis. A. B. Hepler and C. F. Eikenbary. Am. Jour. Surg., October, 1933, XXII, 113–117.

According to the authors, no mention of this condition can be found in a review of the literature. A few cases of perforation of the bladder by sequestra from non-tuberculous osteomyelitis have been reported, but the displacement of the bladder by a massive involucrum as a constantly associated condition has not been considered. They feel that it is fairly frequent, judging from the fact that it was present in each of the four cases of osteomyelitis of the pelvis they have examined. The absence of signs and symptoms referable to the urinary tract accounts for the failure to consider this possible urinary complication. Even in the two cases with perforation, there were no subjective symptoms and examination was undertaken because of persistent pyuria.

The clinical significance of the condition lies, of course, in the possibility of perforation of the bladder, which occurred in two cases and might be assumed to be impending in the others, in which the engendering factors were the same. This should be an additional reason for early and thorough drainage of all suppurative processes in the hip joint or pelvic bones.

The operation for the osteovesical fistule is at times difficult because of the firm adhesions of the contiguous portion of the bladder to the involucrum and the infiltration about the fistula, with danger of laceration. Healing is rapid and the operative results are good. Once corrected, the condition does not tend to recur, provided adequate drainage of the osteomyelitis is established.

DAVIS H. PARDOLL, M.D.

Experimental Ureteral Implantation. Thomas J. Kirwin. Am. Jour. Surg., January, 1934, XXIII, 14–29.

While the present writer has reached the conclusion that intestinal implantation is an operation demanding greater technical skill and knowledge than are at the command of many surgeons working under ordinary conditions of practice, he is nevertheless convinced that the operation should be done whenever possible. Even if the remote results are unsatisfactory, the immediate relief afforded far outweighs the chance of later renal disease. To the question: "Is the relief from the incontinence of ectopia vesicæ, the rapid fatality of vesical carcinoma, or the intolerable suffering endured in tuberculosis of the bladder, worth the possibility of destruction of one or both kidneys, or even eventual uremic death?" his answer would be an emphatic affirmative. Though it is only after much study and animal experimentation that a surgeon can be properly equipped to carry out this procedure, the number of men thus qualified is steadily increasing, though the operation must, of necessity, always be confined to the hands of a few specially selected and trained.

The thought he would leave in the minds of those who have followed this exposition is, that, despite the hazards which attend this operation, notwithstanding the unfortunate remote results which have been reported, and in spite of the many difficulties surrounding it, the implantation of the ureters into the large intestine is a most valuable procedure, and, properly performed, has given extended life, health, and happiness to many who would otherwise have suffered and died most miserably.

DAVIS H. PARDOLL, M.D.

Ureteral Transplantation to the Rectosigmoid for Exstrophy of the Bladder, Complete Epispadias, and Other Urethral Abnormalities, with Total Urinary Incontinence: A Study of 85 Operative Cases. Waltman Walters and William F. Braasch. Am. Jour. Surg., February, 1934, XXIII, 255–270.

The treatment of exstrophy of the bladder and complete epispadias, with total urinary incontinence, is best carried out by transplantation of the ureters to the rectosigmoid. It has been equally well established for treatment of large vesicovaginal fistulas and of other lesions of the bladder and urethra that cause incontinence of urine, if plastic methods of closure cannot be applied. In 85 cases of exstrophy of the bladder and total epispadias, with complete incontinence, encountered at the Mayo Clinic, the ureters have been transplanted to the rectosigmoid in separate stages, without the use of tubes or catheters. The right ureter has been transplanted first, and the left, from 10 to 14 days later, if the patient's condition has permitted.

In a series of 25 cases in which Dr. Walters operated one death occurred. A comparison of morbidity in hospital of the cases in which the ureters are transplanted one at a time, with that in the cases in which the ureters are transplanted simultaneously, would indicate that there is very little difference. Intravenous urography in most of our recent cases has revealed that when the ureters are accurately transplanted by the Coffey submucous method, without use of catheters or tubes, little dilatation of the pelves, calices, or ureters has occurred. The urine is held by a competent anal sphincter for an average of from two to four hours during the day and from three to five hours during the night. Plastic operations on the penis, restoring the contour to normal, are advisable and can be carried out at the time of cystectomy. The aseptic suture method of anastomosis, recently offered by Coffey, does not seem to us to be as useful as the method of submucous transplantation he first presented.

In a series of 42 cases of exstrophy of the bladder, operation was postponed or not recommended.

Intravenous urography and the usual methods of estimating renal function give valuable pre-operative information.

DAVIS H. PARDOLL, M.D.

GYNECOLOGY AND OBSTETRICS

Radiation Therapy of Tuberculosis of the Female Genital Organs. H. Guthmann. Strahlentherapie, December, 1933, XLVIII, 776–789.

The author uses small doses (4 to 12 per cent E.D.), at intervals of from 2 to 3 weeks, in the treatment of tuberculosis of the female genital organs. Of the 515 cases treated by irradiation, 85.9 per cent were either cured or markedly improved, while, on the other hand, 14.1 per cent were either not benefited or they died. The results obtained by operation alone were 64 per cent, and those treated by operation and irradiation were 88.1 per cent. In suitable cases, the combined treatment is, therefore, recommended.

ERNST A. POHLE, M.D., Ph.D.

Pregnancies after Salpingography. Günther K. F. Schultze. Röntgenpraxis, September, 1933, V, 676–678.

The roentgenologic examination of uterus and tubes by means of a contrast medium is not only a valuable diagnostic procedure, but also a therapeutic measure. The author reviews the findings in the cases seen in the Universitäts-Frauenklinik in Berlin. Of 269 cases which could be followed, 115 showed bilateral occlusion of the tubes, 154 (57 per cent) patent tubes. Of these 154, 38 became pregnant after salpingography (25 per cent). If all patients in whom there might be any doubt about the causal connection between lipiodol injection and pregnancy are eliminated, there remains 13 per cent in whom unquestionably the pregnancy was a direct result of the salpingography. In most cases the woman became pregnant within twelve weeks after the examination. The mechanical dilatation of

the cervix, uterus, and tubes by the lipiodol injection, and possibly also a chemical irritation upon the mucosa, is the reason for the therapeutic effect.

H. W. HEFKE, M.D.

THE JOINTS

Thiemann's Epiphyseal Disease. H. Ryffel. Röntgenpraxis, June, 1933, V, 423–432.

Thiemann's epiphyseal disease is found in the epiphyses of the fingers, and sometimes of the toes, in young individuals during puberty. Roentgenologically the epiphyses are seen to be deformed, sometimes in the shape of a meniscus; the central portions are deformed and partially resorbed. The epiphyseal line may be irregular. The proximal interphalangeal joint of the third finger is most often attacked, but others may also show signs of the same disturbance; only the thumb has never been found involved. In three cases reported, the author demonstrated different stages of the disease. The correct diagnosis can be made only during the age of puberty. When the epiphyses disappear, the picture of an arthritis may be the only sign of the disturbance. In one case the disease was so severe that the patient had to change his occupation, yet in many it runs its course unrecognized, because it does not cause any symptoms. In slight cases a perfect healing takes place, while in more marked cases the basis of the diaphyses remains deformed and widened. This disturbance is combined with a hypofunction of the sexual glands in all of the author's cases, and an increase in the size of the hypophysis speaks also for disturbances of the internal secretions. The three patients are children of the same parents, and it appears probable that other adults in the same family also had this disease, which, therefore, seems hereditary.

H. W. HEFKE, M.D.

Arthropneumoradiography in Habitual Luxation of the Shoulder. J. Oberholzer. Röntgenpraxis, August, 1933, V, 589, 590.

In questionable injuries and diseases of the knee joint, 700 arthropneumoradiographies have been done in the hospital from which this article is published. Other joints—for instance, the shoulder joint—have been examined by this method also, but it is more difficult and the results are as yet not entirely satisfactory. The puncture is made between the coracoid process and the tuberculum minus of the humerus. Only oxygen has been injected, not a combination of skiodan and oxygen, as in the knee joint. A case is described in which this method showed nicely the exact localization of the defect of the capsule, and surgical exploration proved the correctness of the radiologic diagnosis. That the method is harmless, if done correctly, is proven by the experience in 700 cases of arthropneumoradiography of the knee joint.

H. W. HEFKE, M.D.

Roentgen Examination of the Shoulder Joint. H. Jordan-Narath. Röntgenpraxis, September, 1933, V, 686–688.

While roentgenograms of the extremities are always done in two planes, the shoulder joint and the surrounding bones are an exception in most instances; one is usually satisfied with the antero-posterior film. Yet the examination of the shoulder in one direction only is just as unsatisfactory as in the case of the extremities—some fracture might be shown only in the axial roentgenogram. It is easy to get it when one has a shock-proof apparatus. The x-ray tube is under the shoulder, the film in an adjustable stand above the shoulder, and the direction of the rays is from below to above the shoulder. This method is well worth while in the opinion of the author, and should be used in all cases of disease or injury of the shoulder.

H. W. HEFKE, M.D.

A Contribution to the Hypertrophic Ossidesmosis. Václav Sváb. Röntgenpraxis, June, 1933, V, 437–440.

According to Kienböck and Selka, hypertrophic ossidesmosis is an ossification of many ligaments of the body (ligaments of the spine, pelvis, etc.). The author observed such a case and describes it in detail. Some of the lumbar vertebræ were connected by thick bony masses; the left ligamentum sacrotuberosum, which leads from the sacrum to the tuberosity of the os ischium, was ossified in its entirety. The hip joints showed evidence of hypertrophic changes. The etiology of this disease is not clear.

H. W. HEFKE, M.D.

THE KIDNEYS

Congenital Pelvic Kidney. B. M. Palmer. Am. Jour. Surg., November, 1933, XXII, 220–222.

This paper presents a case of congenital pelvic kidney containing a stone, and a brief review of the literature. The different forms of operative approach are discussed. A pyelogram should be done in any case of unexplained unilateral pain to rule out anomalies of the urinary tract. The case reported well illustrates the advisability of pre-operative pyelo-ureterograms in all cases in which a stone is thought to be included in the pelvis of a kidney in the ureter.

DAVIS H. PARDOLL, M.D.

Renal Infarcts. Clarence C. Saelhof. Am. Jour. Surg., November, 1933, XXII, 227, 228.

A case of renal infarction is reported. At operation, the true pathologic alteration of renal infarction was observed on gross and microscopic sections. Autopsy revealed multiple thrombi of heart and lungs with terminal infarct formation.

DAVIS H. PARDOLL, M.D.

THE LARYNX

The Roentgen Treatment of Papillomatosis of the Larynx. L. Popp. Röntgenpraxis, October, 1933, V, 739, 740.

Papillomatosis of the larynx is seen much more frequently in children than in adults. It is believed that these papillomas are not newgrowths but areas of inflammatory proliferation. Clinically, papillomas of the larynx are characterized by increasing hoarseness and possibly a laryngeal stenosis. Operative treatment unfortunately does not often effect a cure; recurrences are frequent and dissemination by implantation during operation is possible. The opinion of the author is divided as far as the value of irradiation is concerned. He has treated two such cases (a 30-year-old woman and an 8-year-old child) that were cured by x-ray therapy and remained so for one and one-half and two years, respectively. In children, roentgentherapy is the treatment of choice; in adults, surgical removal followed by roentgentherapy seems to be the more logical treatment.

H. W. Hefke, M.D.

LIPS AND JAWS

Carcinoma of the Lip: Suggestions for its Treatment. R. Stewart-Harrison. Röntgenpraxis, August, 1933, V, 583–586.

The treatment of carcinoma of the lip has changed—surgical treatment is abandoned and the radiotherapeutic method is preferred. From the Roentgen Institute of the University of Zürich (Prof. Schinz), the author quotes statistics and finds that irradiation of the primary tumor in the lip must to-day be the method of choice. When roentgen rays are used in small tumors, 1,500 r in a single dose must be given. Radium, however (especially in molds), is used in the greater number of cases (Regaud's technic)—when the tumor's infiltration is very extensive, radium implantation is preferable. If neighboring structures have been attacked, radium cannot be used, but protracted fractionated roentgen irradiation (about 6,000 r measured in air given in about twenty days) is indicated, sometimes in combination with electrocoagulation. The treatment of the cervical glands is still open to discussion. In Zürich, surgery plus roentgentherapy has been proven satisfactory in most instances. If there is no involvement of the glands demonstrable, surgery is postponed and the patient is carefully watched. Only if there appears to be a good chance of cure of the primary tumor, may the glands be removed surgically and the neck be irradiated, if these glands were metastatic.

H. W. Hefke, M.D.

THE SPINE

Semi-vertebræ as a Cause for Congenital Kyphoses. Herbert Junghanns. Röntgenpraxis, August, 1933, V, 561–563.

Wedge-shaped semi-vertebræ are most often responsible for congenital scolioses. Often one deals with supernumerary semi-vertebræ, which are primarily rectangular, but become wedge-shaped by static pressure. Much more rare are anomalies of a similar nature which cause kyphosis, only about fifteen instances having been described in the literature. The author of the present paper reports two cases.

In a lateral roentgenogram of the spine of a 15-year-old boy, the first lumbar vertebra has been developed only in its posterior half, its shape is rectangular, and there is only a slight degree of kyphosis. The patient showed also symptoms of a chondodystrophy (very low vertebral bodies and very short phalanges). The second case is that of a 45-year-old man in whom the second lumbar vertebra is only half as long in the ventrodorsal axis as the normal vertebræ; the anomalous vertebra is wedge-shaped. There is a marked kyphosis and the anterior edges of the first and third lumbar vertebræ are in direct contact—both show marked hypertrophic spurs. This second case can be considered as the final stage of the anomaly first described in the case of the 15-year-old boy. The history showed that this kyphosis had developed slowly.

H. W. Hefke, M.D.

Some Lacunar Formations Seen Radiographically in the Vertebral Bodies. Desiderio Perotti. Arch. di Radiologia, 1933, XI, Fasc. 3, pp. 552–559.

The author describes and illustrates some lacunar and fissural appearances radiologically visible in the vertebral bodies of adults with spondylitis, with some of the other osteo-arthropathies, with rickets, and with no disease. Perotti is inclined to regard them as vascular lacunæ.

E. T. Leddy, M.D.

Low Back Pain, with Special Reference to Articular Facets; with Presentation of Operative Procedure. Ralph K. Ghormley. Jour. Am. Med. Assn., Dec. 2, 1933, CI, 1773–1777.

Study of the vertebræ and particularly their articular facets makes obvious the importance of the latter in the function of the spinal column. The articular facets must be regarded as the only true joints in the spinal column. Many of the aches and pains which are known as "backache" are true pains of the joints. The degenerative changes that are characteristically seen in hyaline cartilage may be seen in the articular cartilage of these facets, together with the eburnation of the underlying bony trabeculæ. This degeneration may go on to complete loss of the cartilaginous surface, and irregular hypertrophy of the margins, similar to that seen in the advanced stages of degeneration or hypertrophic arthritis of other joints. The facets are not only causes of sciatic pain, but they may be causes of lumbosacral pain, with or without sciatic pain. Roentgenologic evidence is obtainable only by oblique

or three-quarter views and a lateral view of the fifth lumbar and upper sacral vertebræ. The former show the joint space between the articular facets clearly. The combined evidence of the above-mentioned rays presents all evidence necessary in the diagnosis of facet involvement. Treatment is conservative in the majority; in a limited group, for economic and other reasons, surgery is indicated.

C. G. SUTHERLAND, M.D.

Meningocele Simulating an Intrathoracic Tumor. R. Pohl. Röntgenpraxis, October, 1933, V, 747–749.

The roentgenologic differentiation of round shadows in the thorax is often difficult inasmuch as they may have their origin from the lung, pleura, the large vessels, or the thoracic wall. An unusual case is described in which there was a large round, well circumscribed shadow in the right chest and also a marked scoliosis of the thoracic spine. The tumor was thought to be a neurofibroma. At operation a meningocele the size of a fist was found which came from the fourth dorsal vertebra. Too little attention had been paid to the deformity of the dorsal spine. A similar case could not be found in the literature.

H. W. HEFKE, M.D.

THE STOMACH

Syphilis of the Stomach, with Special Reference to its Recognition at Operation. K. A. Meyer and H. A. Singer. Arch. Surg., March, 1933, XXVI, 443–464.

From a surgical standpoint, the distinguishing features between syphilis of the stomach and carcinoma are as follows: There is a striking disparity in many cases between the extent of the lesion as determined roentgenologically and the extent as observed operatively by palpation. In carcinoma, one generally finds at laparotomy a more extensive involvement than the x-ray film indicates. In syphilis of the stomach, there is a surprising paucity or complete absence of changes as determined by palpation. The common lesion of gastric syphilis is not a spherical prominence as in a tumor, gummatous or neoplastic, but is a flat infiltrate that leads to a plaque-like thickening of the gastric wall. When thin, the infiltrate is readily overlooked. When thick, its relatively soft consistency and pliability distinguish it from carcinoma. Inspection of the interior of the stomach generally discloses one or more superficial, serpiginous ulcers involving a large part of the plateau formed by the infiltrate.

HOWARD P. DOUB, M.D.

THE THORAX

Tuberculosis of the Azygos Lobe of the Lung. Giacomo Bagnaresi. Archivio di Radiologia, 1933, XI, No. 4, pp. 697–708.

The author reports three cases of right-sided azygos lobe. In two of them there were clinical and radiologic signs suggestive of a pleuritis of the fissure of the azygos lobe. He emphasizes the difficulty of diagnosing tuberculosis of the azygos lobe and the rarity of this lesion.

E. T. LEDDY, M.D.

Two Unusual Cases of Polylymphglandular Calcification. Giovanni Moschetta. Archivio di Radiologia, 1933, XI, No. 4, pp. 682–696.

The author, after reviewing two cases of extensive calcification of the lymph nodes of the neck, points out the importance the cervical lymph nodes may have in demonstrating a cervico-apical origin of pulmonary tuberculosis.

E. T. LEDDY, M.D.

Post-traumatic Calcifications of the Pleura. Luigi Ferretti. Archivio di Radiologia, 1933, XII, Nos. 5 and 6, pp. 959–969.

This is a radiologic and clinical review of one case of calcification in the pleura, as a result of war wounds.

E. T. LEDDY, M.D.

A Contribution to the Diagnosis and Treatment of Actinomycosis. Andreas Gaál. Röntgenpraxis, September, 1933, V, 650–653.

A 37-year-old farmer was examined one week after the beginning of his sickness, which was diagnosed as a pneumonia with possible abscess formation. An x-ray examination showed two well-circumscribed shadows in the right lung, which showed no inflammatory reaction around them. They looked like metastases or echinococcic cysts. Sputum examination showed the presence of actinomycotic fungi. Irradiation of the diseased lung was undertaken (daily, about 150 r per field). Even with this small dosis, the reaction was very marked and the patient expectorated large amounts of bloody and foul-smelling sputum. A week afterward (three x-ray treatments) the areas in the right lung were much less dense, but there was a new area of infiltration in the left lung. Repeated irradiation achieved complete clinical recovery and disappearance of the lung infiltrations. Beside roentgentherapy, Pot. iodide and Mang. chlor. were given internally.

H. W. HEFKE, M.D.

Interpretation of Chest Roentgenograms. Kennon Dunham. Jour. Am. Med. Assn., Dec. 9, 1933, CI, 1857–1859.

Many years of study of necropsy material to determine the relation between x-ray densities and pathologic observations has demonstrated that the relative degrees of scar tissue and pulmonary exudate can be determined from a study of x-ray films with sufficient accuracy to be of great practical value in the diagnosis,

prognosis, and treatment of pulmonary tuberculosis. The study of a case of pulmonary tuberculosis necessitates the determination of not only the extent and location of the lesions but also the relative amounts of scar tissue (repair, suggesting resistance) and of the pulmonary exudate (acute inflammation). Pulmonary tuberculosis may manifest itself as lobar pneumonia, lobular pneumonia, or bronchopneumonia. Adult apical and subapical tuberculosis starts as a lobular pneumonia and most commonly develops in the posterior apical bronchus, first visualized as a fan in the x-ray plate. Caseous bronchopneumonia usually follows when the lobular pneumonias break down and liberate nascent tubercle bacilli.

Tuberculous lobar pneumonia is not as prevalent as tuberculous lobular pneumonia but is a common lesion. It has been written of as basal tuberculosis. Lobular tuberculosis, a localized inflammation, more frequently repairs and lays down scar tissue and is often spoken of as fibroid tuberculosis. It is all-important to distinguish between scar tissue and pulmonary exudate. If the exudate is spreading, one may expect that an abscess will develop and a cavity form. If the exudate is not spreading, one may expect that scar tissue is being laid down and that absorption is taking place.

C. G. SUTHERLAND, M.D.

Some Consideration of the End-stages of Pneumothorax as Seen Radiologically. V. Podesta. Arch. di Radiologia, 1933, XI, Fasc. 3, pp. 529–551.

As exemplified by 10 cases, Podesta points out some of the criteria and pitfalls to be considered in the roentgenologic study of pneumothorax.

E. T. LEDDY, M.D.

A Pathologic, Anatomic, and Radiologic Study of the Vena Azygos Lobe and the Cardiac Lobe of the Lung. G. Vita. Archivio di Radiologia, 1933, XII, Nos. 5 and 6, pp. 921–941.

The author had occasion to study radiologically and with autopsy control a case having an azygos and a cardiac lobe of the right lung. The patient died from miliary tuberculosis, which in the accessory lobes presented nothing different from what it did in the other lobes. Injection of an opaque medium showed that the azygos lobe had its bronchus markedly kinked at its origin, a fact which may explain the frequency with which these lobes are found to be atelectatic.

E. T. LEDDY, M.D.

Pleural and Pulmonary Calcifications. Rudolf Pohl. Röntgenpraxis, September, 1933, V, 641–649.

Calcifications in pleura and lungs are seen in numerous cases, their demonstration during life being possible only by means of the roentgen ray. Pleural calcifications cannot always be seen fluoroscopically—often a film is necessary. The deposition of calcium takes place almost always in scar tissue, sometimes in nodular form, sometimes in plaques. Usually a pleuritic exudate or an empyema has preceded the calcification. Unquestionably one of the main etiologic factors for it is a hemothorax, following a trauma. These calcifications are most often situated in the basal portions of the lungs, sometimes in the apex, while they are comparatively rare in the interlobar pleura. Calcification in the lung is most often seen as Ghon's primary complex. Intrapulmonary myomas and fibromas may show central deposition of calcium. Chondromas almost regularly show large areas of calcification. Echinococcic cysts may contain lime in their walls. Small areas of calcification may be caused by bronchioliths, the roentgen diagnosis of which is almost impossible. Disseminated calcified areas are seen often in the healed stage of chronic disseminated tuberculosis of the lungs. Calcification in old infarcts has been reported. Linear net-like calcification of the lungs has been reported (pneumopathia osteoplastica racemosa) in the case of old persons and at the periphery of the lungs (two cases are reported). Chronic inflammatory changes are probably an etiologic factor.

H. W. HEFKE, M.D.

The Roentgenologic Appearance of Polycythemia Vera: Also a Contribution to the Roentgenologic Demonstration of Passive Congestion of the Lungs. Brednow. Röntgenpraxis, October, 1933, V, 732–738.

The normal lung markings are due to the shadows of blood vessels, mostly arteries. It is evident that in the cases of polycythemia vera, in which there is considerable increase in the circulating amount of blood, there must be a widening of the lung vessels also.

Three cases are reported. The characteristic roentgen appearance is the much emphasized, sharp reproduction of the blood vessels in both lungs—the ramification of the vessels can be followed into the periphery. Roentgenograms of passive congestion of the lungs are typified not only by an increase in the lung vessel shadows, but also by lack of sharpness in the hilar region. In one case with polycythemia and cardiac failure, the typical picture of a pure polycythemia remained after the passive congestion of the lung disappeared.

H. W. HEFKE, M.D.

Pulmonary Changes in a Case of Periarteritis Nodosa. W. G. Herrman. Am. Jour. Roentgenol. and Rad. Ther., May, 1933, XXIX, 607–611.

In the author's case, a woman, aged 40, entered the hospital complaining of pain in the left shoulder, hacking cough, night sweats, loss of weight, and afternoon temperature. Several weeks after onset of these symptoms, there was numbness in the feet and loss of motor function in the lower extremities. Physical

examination was essentially negative except for the legs, which presented the appearance of polyneuritis. There was a leukocytosis of 22,000. Chest films taken on admission were negative but when re-examined six weeks later, with the physical findings remaining practically negative, there was seen diffuse perivascular infiltration spreading out equally and uniformly from both hilar regions, with the involvement being rather sharply limited about midway in each lung field (this appearance being consistent with the characteristic pathologic limitation to vessels of a given, usually moderate, size). Further x-ray films, taken a few days thereafter, showed more peribronchial or vascular exudation. The patient died about two months later, at which time the changes in the left lung had cleared in part, while in the right chest a pleural effusion had developed. Necropsy showed multiple and diffuse nodosities of periarteritis involving the blood vessels of the kidneys, heart, and lungs. Both the pulmonary and bronchial artery branches were involved. The lungs showed multiple hemorrhagic infarcts.

J. E. HABBE, M.D.

The Normal and Pathologic Azygos Lobe. Bottaliga Mario. Archivio di Radiologia, 1933, XII, Nos. 5 and 6, pp. 1082–1090.

This is a discussion of three cases of azygos lobe encountered in 1,500 radiographs, one with autopsy control, one in which the position of the lobe varied with the position of the patient, and one of interlobar pleuritis checked up two years later and found to have no detectable residual lesion.

E. T. LEDDY, M.D.

TUMORS (THERAPY)

Radiosensitivity of Tumors. Fred W. Stewart. Arch. Surg., December, 1933, XXVII, 979–1064.

This is a long and extremely valuable monograph which it is impossible to abstract in detail as the author covers practically all tumors, and it should be in the files of every radiologist for constant reference. In this abstract we will refer only to some of the general conclusions drawn by the author.

Opinions as to radiosensitivity of tumors are entirely different to-day, with the modern methods of radiation therapy, from what they were in the low voltage x-ray period. Radiosensitivity may mean rapid tumor regression, low progressive regression, or slow chronic atrophy, requiring months or perhaps a year for completion. Radiosensitivity does not mean the certainty of cure by irradiation, nor does radioresistance imply that a given tumor is not curable by irradiation, as certain tumors seem to possess inherent properties of radioresistance, for example, melanomas and neurogenic tumors.

Radiosensitivity increases with increasing embryonal qualities of the tumor cell, although not all tumors of embryonal origin are equally radiosensitive. Radiosensitivity increases with the increasing degree of anaplasia, although not all anaplastic tumors are radiosensitive. Radiosensitivity is always a relative property. When one states that a carcinoma of the breast, for example, is radiosensitive, one should imply that it is sensitive according to the accustomed scale of behavior of tumors of the breast and not according to the same scale of sensitivity one applies to lymphosarcoma.

Tumors are apt to be more sensitive in young subjects. Infection interferes with the normal response to radiation. Desmoplastic tumors are apt to be radioresistant. The tumor bed is of great importance. Bone cartilage and fat make unfavorable media for reactive processes and, hence, for regression of the tumor. An avascular bed is unfavorable for response to radiation. Tumors, when metastatic to lymph nodes, may be more or less sensitive than the primary tumor. Bulky tumors may become resistant after infarction and liquefaction, even though they belong to usually sensitive types. Anatomic characteristics are of decided importance. Among these may be mentioned the papillary character, delicacy of the blood supply, and inclosure within a firm capsule which may result in the obliteration of circulation after irradiation has caused the tumor to become edematous.

The effect of radiation is always complex. It involves not only the tumor cells, but the tissues of the host and possibly general reaction on the part of the host. The ultimate effect of irradiation must always result from a nice balance between tumor effect and response of the tissue host.

HOWARD P. DOUB, M.D.

Radiotherapy as a Method of Identifying Certain Varieties of Tumor. Arthur U. Desjardins. Jour. Am. Med. Assn., Nov. 25, 1933, CI, 1705–1710.

Microscopic examination, until now, has been the only method by which substantial accuracy in the identification of neoplasms can be achieved. Great as is the ability of the really competent pathologist, cases are occasionally encountered in which his interpretation proves to have been erroneous. The most experienced pathologists frankly admit that they are often puzzled and uncertain. The radiotherapeutic method is based on the well-established fact that each variety of cell in the body has a specific sensitiveness or, rather, a specific range of sensitiveness to roentgen rays or radium. A certain measure of variation in reaction must occur. However, if allowance is made for such variation, and if reaction time is taken as a criterion, the specific sensitiveness of each kind of cell looms up as a dominant single fact of radiology and deserves to be recognized as a law. According to present knowledge, cells may be classified, according to their radiosensitivity, in the following order: Lymphoid cells (lymphocytes); polymorphonuclear and eosinophilic leukocytes; epithelial cells: (1) basal

epithelium of certain secretory glands, especially of the salivary glands; (2) basal epithelium (spermatogonial cells) of the testes and follicular epithelium of the ovary; (3) basal epithelium of the skin, mucous membranes, and certain organs, such as the stomach and small intestine; (4) alveolar epithelium of the lungs and epithelium of the bile ducts (liver), and (5) epithelium of tubules of the kidneys; endothelial cells of blood vessels, pleura, and peritoneum; connective tissue cells, muscle cells, bone cells, nerve cells. The difference in susceptibility between lymphoid and epithelial cells is sufficient to enable one to distinguish readily between the two.

Five specific cases are reviewed to illustrate the points of the essay.

C. G. SUTHERLAND, M.D.

The Fate of Fibromyoma of the Uterus after Radiotherapy. James A. Corscaden. Am. Jour. Roentgenol. and Rad. Ther., April, 1933, XXIX, 511–515.

In a series of 452 women treated by x-rays or radium for bleeding and fibroids, there were 130 with a uterus larger than that of a three months' gestation, of which latter group 112 have had follow-up studies. Following diagnostic curettage, the cases earlier treated were given x-rays only, while the later ones had from 600 to 4,800 mg.-hr. of radium filtered by 0.5 mm. silver to 1.0 mm. platinum. With tumors larger than a six months' pregnancy, radiotherapy may control the bleeding and in patients who are poor operative risks at the time it may be definitely indicated, although surgical treatment is more satisfactory when it can be safely done. There were no serious tumor changes (sarcoma, degeneration) in this group of 112 cases, followed for an average period of seven years. Following radiotherapy in sterilizing dose, there was satisfactory shrinkage of the tumor in 90 per cent of the cases. When the cervical canal is long and tortuous, radium may be replaced by roentgen rays and the desired purpose accomplished. Roentgentherapy is safer than radium in the presence of old pelvic inflammatory disease.

J. E. HABBE, M.D.

Report about the Results of Irradiation of Malignant, Tumors in the Year 1932. H. R. Schinz, A. Zuppinger, and R. Stewart-Harrison. Röntgenpraxis June, 1933, V, 401–410.

As in 1930, also in 1931, the results of irradiation therapy in the Roentgen Institute of the University of Zürich are reported. Based on their own results and on comparative studies of the literature, the authors consider the indications for irradiation therapy. In the large majority of carcinomas of the skin, lip, penis, and cervix uteri (both in the operable and inoperable stage), irradiation is the method of choice; also in lymphatic sarcomas, round-cell sarcomas, myelomas, Ewing sarcomas, some ovarian and testicular tumors, and all tumors of the pharynx and larynx. Exclusively surgical are all operable adenocarcinomas (stomach, colon, rectum, kidney, bladder, prostate, and uterus). Irradiation therapy of these tumors, unless they are inoperable, is at present contra-indicated. A combination of surgery and irradiation is used in carcinomas of the mouth and thyroid. In cancer of the breast, Stage I, without glandular involvement, operation without post-operative irradiation is the method of choice, while pre-operative irradiation is indicated in the other stages. In many cancer cases only palliation can be achieved by irradiation.

Of great importance is the fact that the Roentgen Institute has its own hospital department of 30 beds; that is necessary because an intensive radiotherapeutic treatment of a cancer patient is equal to a rather severe surgical procedure and the radiologist should observe and treat his patient daily as much as the surgeon.

From the tables reproduced in this article it appears that from 19 to 28 per cent of all new cases could be made symptom-free at least temporarily, and in another 35 per cent local cure and palliation could be achieved. Altogether, in from 56 to 63 per cent of the patients some beneficial results can be reported. Protracted fractionated and fractionated irradiation were used in the largest percentage of cases. Diagnostic biopsy and co-operation with the surgeon are of much value. Follow-ups of the patients and reliable statistics about three- or five-year cures are hard to get. Results in cases of carcinoma of the lip, larynx, and pharynx are evaluated for longer periods of time.

H. W. HEFKE, M.D.

The Evaluation of Irradiation in Papillary Ovarian Tumors. Stefan Simon. Strahlentherapie, 1933, XLVI, 444–468.

The author describes in detail six cases with ovarian tumors subjected to radiation therapy. Photomicrographs of each growth are shown. Since but little information on this type of malignancy can be found in the literature the article is recommended for study in the original.

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